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CLIMATE CHANGE AND REGENERATIVE AGRICULTURE. CAN CONSUMERS CHANGE THEIR EATING HABITS FOR THE BENEFIT OF THE PLANET?

BACHELOR'S DEGREE IN BUSINESS MANAGEMENT AND ADMINISTRATION

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To Raquel Andrés Martínez, for being my tutor in this challenging experience, for helping me discover new potential in myself, and for always giving me a hand, even on the weekends.

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ABREVIATIONS

CAFOs	Confined Animal Feeding Operations.
FAO	Food and Agriculture Organization.
GHGs	Greenhouse gases.
GWPs	Global warming potentials.
IDE	Integrated Development Environment
i.e.	*id est*, that is.
IPCC	Intergovernmental Panel on Climate Change.
Post hoc	After this.
UNEP	United Nations Environment Programme.
U.S.	United States.
WHO	World Health Organization.

ABSTRACT

Climate change is happening. Since the end of the XIX century, the global temperature has increased dramatically. Human activities such as deforestation, burning of fossil fuels, industrial agricultural production, and industrial farming, among others, are ultimately causing the meltdown of ice and snow, the raise in sea levels, the rise in global temperature, the increase in droughts, and infectious diseases, and the degradation of ecosystems. There is no agreement by the scientific community about the solutions to climate change. Nevertheless, this study presents the soil as the key for it, and regenerative agriculture as the new revolutionary approach, opposite to the damaging agricultural production industry. In that regard, most of the human activities that are causing climate change are related to the food production industry and that is the reason why we conducted survey-type research to analyze if the 2021's Spanish population would be willing to change their eating habits in favor of climate change. The results showed that even though there is a need for more knowledge regarding the impact of the agricultural and farming industries on the climate, most participants stated that they would be open to change their food habits if that implies a new opportunity for our planet, and thus, for the human species.

Keywords: climate change, drivers of climate change, consequences of climate change, livestock, regenerative agriculture, soil, food habits, awareness.

1. INTRODUCTION

In recent decades, anthropogenically-induced changes in climate have caused impacts on natural and human systems on all continents and oceans, the extent of which is still unknown. These changes prove the sensitivity of natural and human systems to a changing climate. Moreover, our food habits have a big impact not only on our health but also on the climate and environment. Maintaining a sustainable healthy diet is crucial for us to survive and the planet to survive with us too.

This study was inspired by the Netflix documentary “Kiss The Ground”, which talks about new perspectives that lead to new solutions to climate change, especially regenerative agriculture. I have always been concerned about the environment and the damage humans are causing to the planet, resulting in drastic climate changes whose repercussions may be irreversible. For this reason, when I heard about this new regenerative agriculture technique that could not only stop but reverse climate change, I wanted to study it. Moreover, I am pretty concerned about what I eat. Due to ethical, environmental, and spiritual reasons, I chose a vegan diet, so I had to do extensive research on what to eat and how to eat it to give my body all the vitamins, protein, etc, that it needs. Added to this, I developed several food intolerances a few years ago, and this made me do even more research about the properties of each aliment, so I could find why my body reacted so aggressively towards some of them. In this research, I found lots of articles that exposed how the food industry is not only bad for humans due to the unhealthy ingredients that were added to the food, but also about animal torture, sea life extinction, and environmental degradation that made me feel like I should do something about it. I was unaware that the food industry was so linked to climate change. This study is the result of many months of literary research that came out of it. It also encouraged me to change some of my food habits, such as buying directly from the local farmers that follow a regenerative agriculture system and finding joy in doing so. With this paper, I aim its readers to think of what impact is that they are making in the world right now and if it is the one they really want to make. Here you have some information that may help you stick to your decisions and lifestyle, or switch to a new one. We must make the right choices, not only for our own health but for the planet's survival. Earth day is every day. We must save it.

Regarding its structure, the study is divided into seven sections. The first section reviews and differentiates the basic and most important concepts to understand climate change and all the phenomena involved in it. The second section focuses on the drivers of climate change and analyses in depth the most important anthropogenic causes that influence the soil, which are the greenhouse gas emissions through deforestation and burning of fossil fuels, industrial agricultural production, and industrial intensive farming as well. The third section tackles some of the current known consequences of climate change, describing its characteristics and implications for the

environment, biodiversity and human health and survival. The fourth section presents the basic aspects of the new possible solution to climate change: regenerative agriculture. It focuses on its definition, the reasons why it may be the best solution that exists nowadays, how does it work, its basic principles, and its relationship with the food industry. The fifth section brings about an exhaustive research study that has been made for this specific paper in order to find out, through a questionnaire and its later statistical analysis, the level of awareness of the population regarding the climate situation, the knowledge of regenerative agriculture, the relationship of these two factors with their food habits and their willingness to change them for the benefit of the planet. The sixth section is the discussion, which includes the major finding of the statistical study, the meaning of those findings, its limitations, explanations for surprising and unexpected results, and suggestions for further research. Finally, the seventh and last section exposes all the conclusions of the study, section per section, including both the theoretical and the statistical analysis.

Without further ado, let us start with the study.

2. CLIMATE CHANGE. A BRIEF OVERVIEW.

Climate change is nowadays one of the biggest and most threatening concerns of our society.

However, some of the concepts that define it or that come along with it are sometimes misunderstood or misused by the media, the environmentalist groups, or the general public. In this first section, we will review the most important concepts in the study of the atmosphere and the climate to ensure that the basics of this phenomenon are covered.

2.1. The greenhouse effect.

The greenhouse effect is a natural mechanism through which the Earth's atmosphere warms up[1]. But what is the atmosphere?

The Earth's atmosphere is a thin layer of gases that surrounds the planet. These gases are fundamental to the development of life on Earth but also on the atmosphere itself as it is where a good part of the planet's life resides. The chemical composition of the atmosphere mostly includes two gases, which are Nitrogen (N) by 79% and Oxygen (O_2) by 20%. The remaining percentage of 1% is made up of various gases such as Argon (Ar) by 0.9%, carbon dioxide (CO_2) by approximately 0.03%[2], and water vapor or steam by 0.0009 %[3]. Nevertheless, the climate importance of each of these gasses is not directly related to its proportion in the atmosphere. The small proportion of the latter gases mentioned are of crucial importance in the process of warming the atmosphere, especially CO_2 and water steam. The gases that contribute to the greenhouse effect are called the greenhouse effect gases, and they are mainly steam, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons, (HCFCs), ozone (O_3), and hydrofluorocarbons (HFCs), among others, that absorb infrared radiations[4].

Now, what is it that warms up the atmosphere? The sun, the earth's surface, the gases themselves? The gases in the atmosphere are subject to the Earth's gravitational pull. Thus, the highest density of gases is concentrated near the Earth's surface, in the first 50 km, where we can distinguish two layers: the troposphere, which covers the first 10 km closest to the Earth's surface and has about

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[1] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático: una perspectiva desde las ciencias de la tierra", *Revista Digital Universitaria Unam*, Vol.8, Nº 10 (2007), p. 3, http://www.revista.unam.mx/vol.8/num10/art78/int78.htm [accessed 2021-02-20].

[2] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.3.

[3] MARTÍNEZ ARROYO, A., "El agua en la atmósfera", *Ciencia*, 2007, p. 36, https://www.amc.edu.mx/revistaciencia/images/revista/58_3/PDF/06-546.pdf [accessed 2021-02-23].

[4] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", *Ciencia UANL*,Vol.VI, Nº 3 (2003), p.379, http://eprints.uanl.mx/1287/ [accessed 2021-02-20].

75% of the total mass of the atmosphere; and the stratosphere, which reaches up to 50 km in height and has 24% of the total mass of the atmosphere. Together, Troposphere and Stratosphere concentrate 99% of the total mass of the atmosphere[5]. Although the sun is closer to the stratosphere than to the troposphere, the highest air temperatures are found in the latter mentioned, right at its contact point with the solid surface of the Earth where it reaches about 15 - 20ºC. From there up to 10 km, the air temperature gradually drops until it reaches – 60ºC, as figure 1 shows.

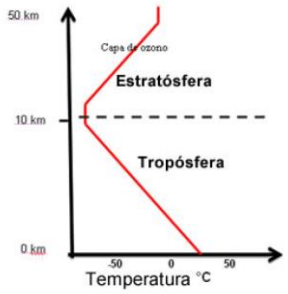

Figure 1. Structure of the troposphere and stratosphere[6]

If we think that the source of heat for the atmosphere is the Sun, we would expect, as we just mentioned, that the closest layers to the Sun were the warmest. However, the gases of the atmosphere cannot absorb sunlight because it radiates high energy in the form of shortwave radiation and the gases can only capture longwave radiation, the reason for which most of the energy passes to the Earth's surface, warming it up. Thereafter, sunlight is transformed into heat-radiation in the form of longwave radiation (infrared rays) that reflects into the atmosphere, where some of the atmospheric gases, in particular CO_2 and steam, can absorb it efficiently and consequently warm up the air, avoiding that the heat escapes into outer space. Now, it makes sense to say that the highest temperature of the troposphere is found in the point of contact with the surface of the Earth.

This is how the greenhouse effect works naturally and it is necessary for life on Earth to exist because it heats the atmosphere, and it raises its average temperature. Without it, the Earth would be frozen, and the average global temperature would be about -18 ºC instead of the very comfortable 15 – 20 ºC that is now. Thanks to the greenhouse effect the Earth's surface warmed up enough to allow the creation and maintenance of life on the planet[7].

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[5] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.4.
[6] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.4.
[7] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.377.

It is clear, then, that the composition of the atmosphere fundamentally affects the climate. The more percentage of greenhouse gases (hereinafter, GHGs) like CO_2 are in the Earth's atmosphere, the higher the global temperature will be on the planet. Conversely, the less there is, the colder the Earth. Nevertheless, if the concentration of GHGs continues to increase mainly due to anthropogenic causes, i.e., human activity as it has been happening for the last 250 years[8], the Earth will undergo additional warming of unknown precise consequences[9].

2.2. Global warming phenomenon

The next concept to approach is global warming, which is the continuous and gradual increase of the average temperature of the Earth's surface, responsible for the changes in the global climate patterns[10]. Although in the past there has been a temperature increase as a result of natural influences, the term global warming is mostly used now to refer to the warming of the Earth's surface caused by human activities since the early 20th century mainly due to an increase in the GHGs concentration in the atmosphere (mainly water steam, which is the most important greenhouse gas, followed by $C0_2$ which is the most related to human activity), i.e., an intensification of the greenhouse effect. As they go hand in hand with one another, sometimes the two concepts of global warming and the greenhouse effect can be misunderstood or used indistinctively, but they are not the same. While one describes the phenomenon of the recent increase in temperature on Earth, the other refers to the mechanism that causes it[11].

The average global temperature has increased over the past century in a way that had never before, and that brings unusual changes with it in other climate factors, hydrological cycles[12], biogeochemical cycles[13], etc. For instance: there has been a decrease in the Earth's surface

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[8]From 280 ppm (parts per million) in 1750 to 353 ppm in 1990 and continues to increase at a rate of 1.8 ppm per year. It is estimated to reach a level between 550 and 700 ppm by 2050 (GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.378).

[9] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.380.

[10] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.379.

[11] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.5.

[12] The hydrological or water cycle is the continuous circulation of water within the Earth's hydrosphere, and it is driven by solar radiation. This includes the atmosphere, land, surface water and groundwater. As water moves through the cycle, it changes state between liquid, solid, and gas phases. Water moves from compartment to compartment, such as from river to ocean, by the physical processes of evaporation, precipitation, infiltration, runoff, and subsurface flow (EUROPEAN ENVIRONMENT AGENCY. (n.d.). *Hydrological cycle.* https://www.eea.europa.eu/archived/archived-content-water-topic/wise-help-centre/glossary-definitions/hydrological-cycle [accessed 2021-02-24]).

[13] The biogeochemical cycle is the cyclical movement of elements between living organisms (the biotic phase) and their non-living (abiotic) surroundings (e.g. rocks, water, air). Examples of biogeochemical cycles are the carbon cycle, nitrogen cycle, oxygen cycle, phosphorus cycle, and sulphur cycle

covered by snow or ice (glaciers are melting, both those in the mountains and those that form the Arctic and Antarctic ice caps), the time when some lakes and rivers remain frozen has been reduced during the year, there has been an increase in the average sea level due to the glacial meltdown which contributes to more floods in the coastal cities, there have been changes in the distribution of diseases as well as in agriculture patterns, rainfall patterns, wind speed, cloudiness and in the frequency and intensity of extreme weather events, and phenomena like "El Niño" and "The Girl" have increased too. In fact, since the end of the XIX century, the global temperature has increased almost 1ºC the XX century, which, according to recent studies, suggests that the registered XX century global warming goes in the opposite direction to the general cooling tendency of the last century[14]. In fact, since the mid-1970s, the rate of increase in temperature rises has tripled and the Intergovernmental Panel on Climate Change[15] predicts increases of 1.8–3.9°C (3.2–7.1°F) by 2100[16].

Now, even if the reason for this unusual increase of CO_2 might have been linked to natural processes, there is a significant human component, as logging and burning of fossil fuels such as coal and oil have led to an increase in the amount of CO_2 in the atmosphere, increasing the greenhouse effect and global warming as well. If the natural processes have always been the same, it makes no sense that there is a much more pronounced rise in temperature from 1980 to date. Thus, we need another factor to explain it, which is the contribution of human activities, as it has been observed by different climate models[17].

(BIOGEOCHEMICAL CYCLE. *(N.d.)*. Oxford Reference. https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095506949 [accessed 2021-02-24]).
Human activities have mobilized Earth elements and accelerated their cycles, for instance, more than doubling the amount of reactive nitrogen that has been added to the biosphere since pre-industrial times. Global carbon dioxide emissions are the most significant driver of climate change caused by humans. But human-accelerated cycles of other elements, especially nitrogen, phosphorus, and sulphur, also influence climate. Thus, climate change is having, and will continue to have, impacts on biogeochemical cycles, which in turn will alter future impacts on climate and affect our capacity to cope with coupled changes in climate, biogeochemistry, and other factors (NATIONAL CLIMATE ASSESSMENT.(n.d.). Biogeochemical cycles. https://nca2014.globalchange.gov/report/sectors/biogeochemical-cycles [accessed 2021-02-24]).

[14] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.378.

[15] DESCRIURE'L UNA MICA

[16] (KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming: Impacting and Mitigating Climate Change", *Environmental Health Perspectives*, Vol.116, Nº5, (2008), p. 578,
https://ehp.niehs.nih.gov/doi/pdf/10.1289/ehp.11034 [accessed 2021-03-06].

[17] Mathematical representations of the atmosphere interactions, oceans, Earth surface and real or potential climate-simulating glaciers (GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.380).

2.3. Climate change

The last important concept is climate change. This term is used to describe the current significant change in the climate that does not seem to relate to its natural cyclical variations. The climate is never static and there are annual cyclical fluctuations as well as occasional variations due to natural phenomena such as volcano eruptions[18].

Climate change is caused by global warming which has its total or partial origin in the increase of GHGs in the atmosphere (the greenhouse effect), which in turn affects the planet's temperature and rainfall patterns, as well as the frequency and severity of extreme events such as hurricanes and droughts.

As we may already know by now, the global climate of a planet is determined by its total mass, its distance from the sun, and the composition of its atmosphere. The Earth's climate variability, however, is determined by the variation in the greenhouse gas concentration, the solar, and volcanic activity. The first one is mostly caused by human activity, while the other two are mostly naturally based. Thus, the more plausible idea is to determine that the new variations of the climate have been created by human activity, due to an increase in the concentration of the gases that contribute to global warming and that alters the world climate. And that goes along with the scientific certainty that GHGs have been the main contributors to climate change during the XX century among the three mentioned before[19].

It is necessary to control the CO_2 emissions that we are throwing into the atmosphere because if this gas continues to increase the way it is doing, we do not know what response the planet's climate system is going to have. It is well known that the planet has been oscillating between glacial and interglacial periods for de last 400,000 years[20] and it has always found a way to balance itself naturally. However, if the change is very intense, then we can force the planet into a new state of balance, with consequences that are difficult to predict. Moreover, it is important to remark that the changes in CO_2 concentration and climate type coincided with the largest mass extinction event on Earth's history, known as the Permo-Triassic extinction, which marked the separation of the two geological eras of Paleozoic and Mesozoic. Nevertheless, after this abrupt change, gradually new species evolved under the new balanced conditions and the planet kept on spinning with new dominant species. According to this, if our species is the currently dominant

[18] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.379.
[19] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.378.
[20] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.9.

one, a drastic climate change like the ongoing -and as the Permo-Triassic was- could affect us in a way that a new period of evolution and biological diversification would start, and it is not possible to know if we would keep the same dominant position as nowadays[21].

To sum up, the current climate change is a phenomenon caused totally or partially by the increase in the GHGs concentration in the atmosphere, mainly CO_2, directly or indirectly related to human activities such as the use of fossil fuels and deforestation.

In fact, many scientific studies show that climate change is already affecting the biosphere.

Nevertheless, although most attention has focused on CO_2 due to its great number of emissions, methane and nitrous oxide (N_2O)—both extremely potent GHGs —have greater global warming potentials (hereinafter, GWPs) than does CO_2. For instance, by assigning CO_2 a value of 1 GWP, the warming potentials of the other gases can be expressed on a CO_2-equivalent basis: CH_4 has a GWP of 23, while N_2O has a GWP of 296[22]. These two gases have mote potential to be more harmful to the environment, but there are way fewer emissions than CO_2, reason why this last one is the biggest contributor nowadays. Nevertheless, we also need to worry about reducing the emissions of these other two gases due to their great potential to cause global warming.

As humans are accountable for it and it affects life throughout the planet, climate change, as well as the other environmental problems that surround it, must be known and understood, not only by technicians and scientists but also by the general population, so we can all make a change towards a more respectful impact on Earth.

[21] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.10.
[22] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.578.

3. MAIN CAUSES OF CLIMATE CHANGE

Regarding climate change and its drivers, there is no agreement by the scientific community[23]. A few consider that it is a natural event that is part of a cycle that will last a few more decades, while the majority state that even if part of it could be a natural cycle, at least its partial, not to say total origin, is in the human activities, mostly through the use of fossil fuel and deforestation during the last 250 years[24].

Before we start enumerating the drivers of climate change, it is important to remark that even the natural processes can be contributors in a way, this would not take us as far as we are nowadays.

The most relevant causes of climate change are greenhouse emissions that happen through deforestation, burning of fossil fuel, agricultural activity, farming, polluting transport, energy consumption, excessive waste, among others, and they are the main anthropogenic cause. Volcanic and solar activity are the main natural ones.

Among all the drivers of climate change, this study will mainly focus on the anthropogenic causes, particularly deforestation, burning of fossil fuel, agricultural and farming activities and their influence in soil treatment, as they are the main reason why we are in this alarming climate situation.

3.1. Greenhouse gas emissions

Greenhouse gas emissions are the main cause of climate change, not because they exist as they allow life to happen on Earth, but because humans have been increasing its concentration in the atmosphere up to dangerous levels and the consequences of which are unknown.

The burn of fossil fuels and deforestation are the main anthropic contributions to global warming. Together they deliver about 7.5 billion tons of carbon per year to the atmosphere, against the approximately 100 million tons per year attributable to natural sources[25] such as vulcanism.

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[23] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.380.
[24] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.
[25] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.6.

3.1.2. Deforestation

Deforestation is the cutting down of trees in a large area or the destruction of forests by people[26]. The mass destruction of trees is largely referred to as a phenomenon and problem in developing countries, even though much deforestation has already occurred in developed countries[27]. Agriculture, and especially livestock, are the main causes of deforestation and the destruction of valuable ecosystems[28].

Why is deforestation the cause of most of the CO_2 emissions on the planet? Photosynthesis is a process that sets CO_2 in living tissue (or biomass), first from plants and then from animals, which is returned to the atmosphere by breathing organisms. However, photosynthesis often exceeds the process of breathing, *i.e*., living things become a carbon deposit that takes CO_2 away from the atmosphere and stores it in the biomass, which in turn is mainly concentrated in forests and jungles[29].

Biomass, at its death, can be stored in soils or sediments and eventually buried, so that ancient biomass can be transformed into coal or oil. In this case, the CO_2 does not return to the atmosphere and so it prevents an excessive quantity of this gas in the air.

This is the natural process that, as we explained above, affects the climate, but it does not cause the current dangerous climate change situation. What is responsible for it is the process of deforestation, so when the forests are cut down, large amounts of biomass are burned, and with it, the CO_2 stored in the trees quickly returns to the atmosphere. This is a problem, as the biosphere can go now from being a reservoir to a source of CO_2 if deforestation is not controlled.

Global effects of deforestation include loss of biodiversity and changes in the carbon cycle (biogeochemical cycle). Moreover, the loss of tree cover can destabilize the hydrologic cycle, leading to a drier climate, desiccated soils, erosion, regional climate change, and increased flood risks in downstream areas. This leads to a lowered agricultural productivity as a form of resource

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[26] CAMBRIDGE ENGLISH DICTIONARY. (N.d.). Deforestation. https://dictionary.cambridge.org/dictionary/english/deforestation [accessed 2021-02-25].

[27] WALKER, R., "Deforestation and Economic Development", *Canadian Journal of Regional Science*, XVI:3 (1993), p. 486, https://www.researchgate.net/publication/259470503_Deforestation_and_Economic_Development [accessed 2021-02-25].

[28] BERMEJO, I., "Agricultura y cambio climático", *El Ecologista*, Nº.67 (2010/11), https://www.ecologistasenaccion.org/19945/agricultura-y-cambio-climatico/ [accessed 2021-03-04].

[29] CABALLERO, M., LOZANO, S., Y ORTEGA, B, "Efecto invernadero, calentamiento global y cambio climático", cit., p.6.

abuse in developing countries but also bearing in mind that deforestation that leads to productive and sustainable agriculture happens and cannot be regarded as environmental degradation[30].

If we look at numbers, according to National Geographic[31], forests just cover about 30% of the world's land area and they are disappearing at an alarming rate. Yet, they provide habitat for most of the terrestrial plant and animal species known to science. Unfortunately, forests and all the biodiversity they contain continue to be under threat from actions to convert the land to agriculture or unsustainable levels of exploitation, much of it illegal[32].

The World Bank stated that between 1990 and 2016, the world lost 502,000 square miles, i.e., 1.3 million square kilometers of forest[33]. Since humans started cutting down forests, 46% of trees have been felled and about 17 % of the Amazonian rainforest has been destroyed over the past 50 years.

The report of the Food and Agriculture Organization (hereinafter, FAO) and the United Nations Environment Programme (hereinafter, UNEP)[34] states that, since 1990, around 420 million hectares of forest have been lost through conversion to other land uses. The area of primary forest worldwide has decreased by over 80 million hectares since 1990. Moreover, more than 100 million hectares of forests are adversely affected by forest fires, pests, diseases, invasive species, drought, and adverse weather events. Agricultural expansion continues to be the main driver of deforestation and forest fragmentation and the associated loss of forest biodiversity. This same report explains what the main drivers of deforestation and forest degradation are, and it expresses it through a graphic by region from 2000 to 2010 as Figure 2 illustrates.

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[30] WALKER, R., "Deforestation and Economic Development", cit., p.483.
[31] NATIONAL GEOGRAPHIC. (N.d.). *Deforestation explained.* *https://www.nationalgeographic.com/environment/article/deforestation* [accessed 05/02/2021].
[32] FAO and UNEP, "The State of the World's Forests 2020. Forests, biodiversity and people", Rome (2020), p.1-214, https://doi.org/10.4060/ca8642en [accessed 05/02/2021].
[33] NATIONAL GEOGRAPHIC. *Deforestation explained., cit.*
[34] FAO and UNEP, "The State of the World's Forests 2020", cit., p.16.

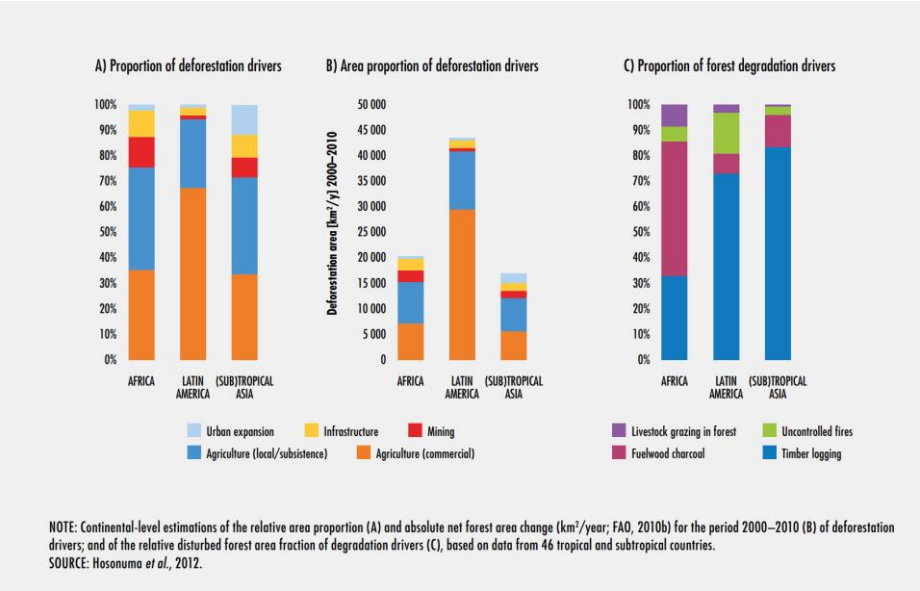

Figure 2. Drivers of deforestation and forest degradation by region, 2000 ï 2010[35]

As mentioned by the Food and Agriculture Organization of the United Nations[36], the total forest area is 4.06 billion hectares or approximately 5000m^2 (or 50 x 100m) per person. Nevertheless, forests are not equally distributed around the planet: more than half of the world's forests are found in only five countries, which are the Russian Federation, Brazil, Canada, the United States of America, and China. Also, two-thirds or 66% of all forests are found in ten countries, which shows this unequal distribution. The following figures show this unequal distribution.

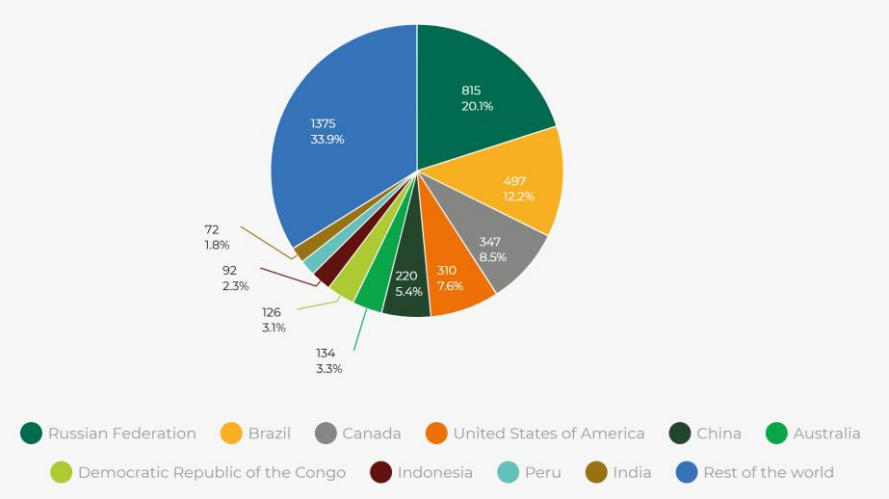

Figure 3. Global distribution of forests showing the ten countries with the largest forest area, 2020 (million hectares and % of world's forest)[37]

[35] FAO and UNEP, "The State of the World's Forests 2020", cit., p.83.
[36] FAO and UNEP, "The State of the World's Forests 2020", cit., p.10.
[37] FAO and UNEP, "The State of the World's Forests 2020", cit., p.10.

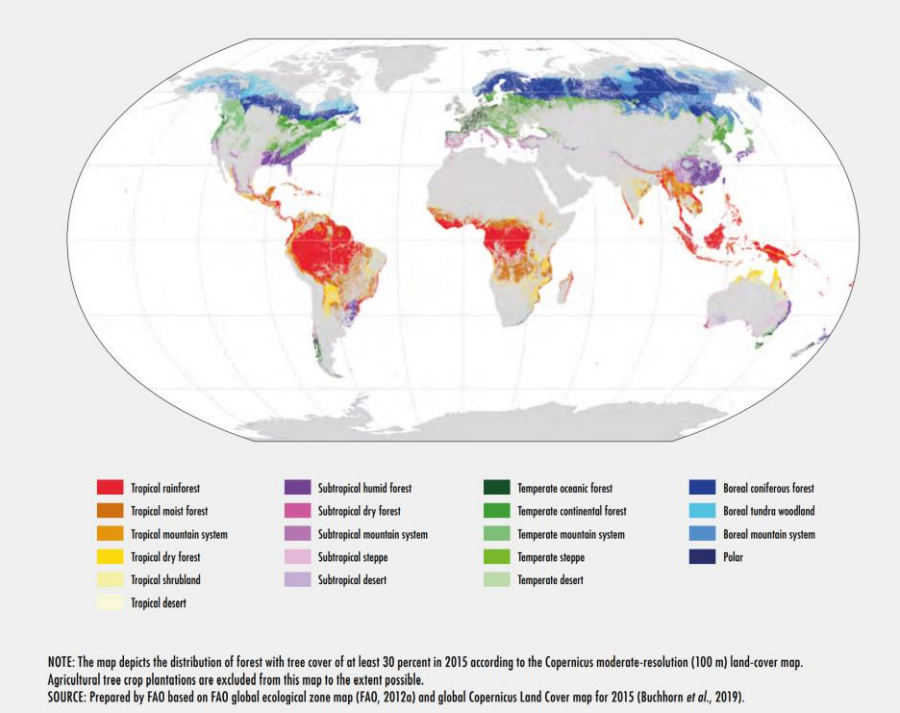

Figure 4. Forest by global ecological zone[38].

To conclude with this section and remark the importance of reducing deforestation, in words of the Intergovernmental Panel on Climate Change (hereinafter, IPCC)[39]: "Natural CO_2 sinks, such as vegetation and oceans, remove about half of all emissions from human activities. This underscores the need to reduce deforestation and expand natural CO_2 sinks, particularly those in forests and soils that can be improved by better management and habitat restoration".

3.1.3. Burn of fossil fuels.

As a brief contextualization, our ancestors relied on very basic forms of energy such as human muscle, animal muscle, and the burning of biomass (wood, crops...). The Industrial Revolution unlocked a new energy resource: fossil fuels (coal, oil, gas). Since then, fossil energy has been a fundamental driver of technological, social, economic, and development progress and it still plays a dominant role in the current global energy system[40]. Nevertheless, it has a negative impact: when burned, fossil fuels release CO_2. Some of it was stored for millions of years and is now being rapidly returned to the atmosphere, increasing its levels and overheating the planet. Burning

[38] FAO and UNEP, "The State of the World's Forests 2020", cit., p.19.
[39] IPCC. (2019). *Landmark United in Science report informs Climate Action Summit*. https://www.ipcc.ch/2019/09/22/united-in-science-report-climate-summit/ [accessed 03/03/2021].
[40] RITCHIE, H., ROSER, M. (N.d). *Fossil fuels.* Our World in Data. https://ourworldindata.org/fossil-fuels [accessed 04/03/2021].

fuels contributes to local air pollution, which is estimated to lead to millions of premature deaths each year[41].

The following figure shows which countries use the most energy from fossil fuels each year. The United States, by far, takes the lead.

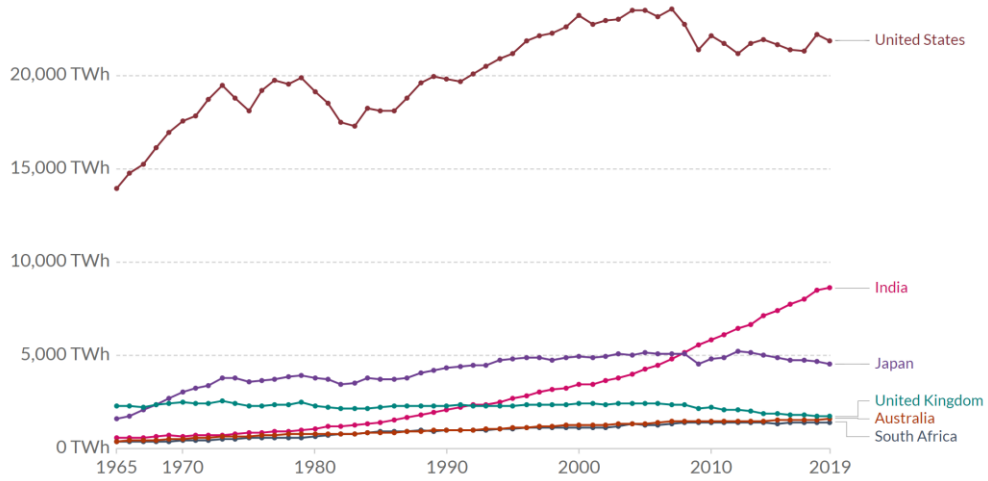

Figure 5. Fossil fuel consumption per year [42]

The next figure shows the most used fossil fuel types in the world, which are oil, followed by coal, and ending with gas. The alarming factor is that the levels of consumption have increased to date, so a change in energy management is urgently needed.

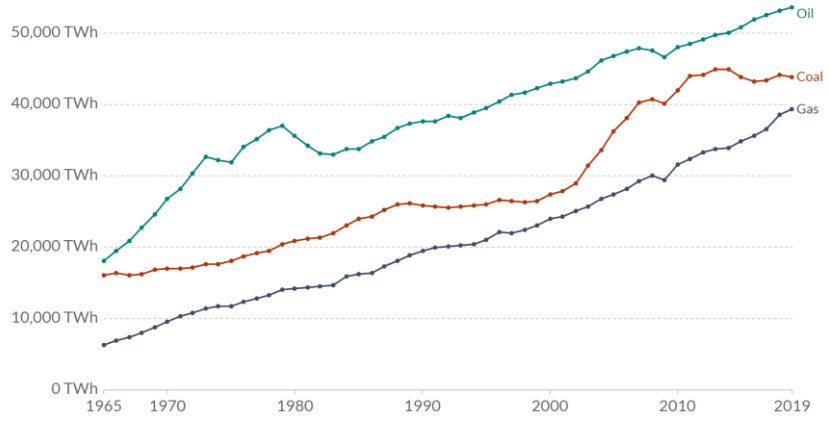

Figure 6. Fossil fuel consumption type in the World[43]

All in all, according to 2019's IPCC report[44] and despite the extraordinary growth in renewable fuels over the past decade, the global energy system is still dominated by fossil fuel sources. Fossil

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[41] RITCHIE, H., ROSER, M., *Fossil fuels*, cit.
[42] RITCHIE, H., ROSER, M., Fossil fuels, cit.

[43] RITCHIE, H., ROSER, M., *Fossil fuels*, cit.
[44] IPCC, *Landmark United in Science report informs Climate Action Summit, cit.*

fuel continues to grow, as the annual increase in global energy use is greater than the increase in renewable energy. To stabilize the climate, a drastic reduction of the use of fossil fuels as the main energy source is needed, as well as an acceleration of the non-carbon energy sources usage.

3.2. Changes in agricultural patterns. From industrial agricultural production to agroecological systems.

With the so-called "Green Revolution", industrial agriculture was born. Its aim was the massive increase in food production, moving away from traditional methods. Nevertheless, the sad reality is that nowadays between 30 and 50% of food is thrown away, while the number of starving people continues to grow and already reaches the frightening figure of 1 billion people. Moreover, the number of people being overweight and obese, which is the fifth leading cause of death risk according to the World Health Organization (hereinafter, WHO), affects 1.5 billion people[45]. This does not look like the right path to follow.

The current model of agriculture and intensive livestock is one of the main causes of climate change. The highest direct emissions from agriculture are due to overuse of fertilizers, destruction of ecosystems, soil degradation, and intensive livestock model[46].

According to the IPCC, agriculture is responsible for 10-12% of the total global anthropogenic emissions and 24% of the increases in atmospheric GHG emissions. The large majority of total agriculture related GHGs emissions come from industrial agriculture, which is not surprising considering the global modes of production. This type of agriculture uses high degrees of mechanization, high stock densities, large-scale monocrops, high levels of agrochemicals, high-yielding plant and animal varieties, and decreased or absent fallow periods[47]. As the crops are so uprooted from nature, they generate imbalances, and lands are impoverished and become vulnerable to diseases and pests. Thus, there is a need to apply large doses of chemicals such as synthetic fertilizers, pesticides, and herbicides, with very high environmental impacts like soil pollution, aquifers pollution, and watercourses pollution, as well as effects on living beings such as the decline of the bee population, which at the same time serves as an alert to what we are

[45] GREENPEACE. (N.d.). *Agricultura industrial*. http://archivo-es.greenpeace.org/espana/es/Trabajamos-en/Transgenicos/Agricultura-industrial/ [accessed 2021-03-04].
[46] GREENPEACE, *Agricultura industrial*, cit.
[47] B. LIN, B., VANDERMEER, J., et al., "Effects of industrial agriculture on climate change and the mitigation potential of small-scale agro-ecological farms", in: HEMMING, David, Animal Science Reviews 2011, CAB Reviews, p.1-256.

doing wrong. In fact, many of these chemicals are related to carcinogenic diseases or act as hormonal disruptors in the human body[48].

Conventional or industrial agricultural production is not only related to the extension of monocrops but also deforestation of valued ecosystems and even primary forest[49]. This type of agriculture emits three important GHGs, which are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Although most attention has focused on CO_2 as the main GHG, these other two gases have a greater global warming potential in agriculture and farming. In fact, agricultural activities are responsible for 50% of global atmospheric inputs of CH_4, and agricultural soils are responsible for 75% of global N_2O emissions[50]. The following table illustrates the potential sources of GHGs emissions from the agricultural systems.

CO_2 emissions	CH_4 emissions	N_2O emissions
• N fertilizer production • On farm fossil fuel, feed • On farm fossil fuel, livestock related • Deforestation • Cultivated soils, tillage • Desertification of pasture • Processing • Supply chain operations: packaging, cold chain and transport	• Enteric fermentation • Manure management • Methanogenesis from water logged soils • Agricultural waste burning	• N fertilizer application • Indirect fertilizer application • Leguminous feed cropping • Manure management • Manure application/deposition • Indirect manure emissions

Figure 7. Potential sources of GHGs emissions from agricultural systems[51].

As we know, before we can consume it, food is produced, stored, processed, packaged, transported, prepared, and served. At each stage, food provisioning releases GHGs into the atmosphere. On the one hand, farming releases significant amounts of CH_4 and N_2O. CH_4 is produced by livestock during digestion (enteric fermentation) and it is released via belches or from stored manure and organic waste in landfills. On the other hand, N_2O emissions are an indirect product of organic and mineral nitrogen fertilizers[52].

The alternative to industrial agricultural production exists. Ecologically based methods consume far less energy and thus release less GHGs than industrial agricultural production. Moreover, agroecological management techniques restore soils and can sequester more GHGs than industrial agriculture, i.e., there is a better carbon absorption capacity of soils as they sequester more carbon

[48] GREENPEACE, *Agricultura industrial*, cit.
[49] GREENPEACE, *Agricultura industrial*, cit.
[50] B. LIN, B., VANDERMEER, J., et al., "Effects of industrial agriculture on climate change and the mitigation potential of small-scale agro-ecological farms", cit., p.1-256.
[51] B. LIN, B., VANDERMEER, J., et al., "Effects of industrial agriculture on climate change and the mitigation potential of small-scale agro-ecological farms", cit., p.1-256.
[52] EUROPEAN ENVIRONMENT AGENCY. (2015). *Agriculture and climate change.* https://www.eea.europa.eu/signals/signals-2015/articles/agriculture-and-climate-change [accessed 2021-03-04].

in biomass[53]. Agroecological systems are generally based on species diversity (variety of crops, companion plants, population insects, soil microbial and fungal diversity, birds, and vertebrate lifestyle). Some of its practices include cover cropping, lengthened fallows, fertilization with animal manure, intercropping, crop rotation, biological pest control … which allows eliminating or at least minimizing the use of external and synthetic inputs, including fossil fuels and replacing them with ecologically driven processes.

Despite the percentages stated above, there is a counterpoint to mention. Agriculture is the sector with the most greenhouse emissions worldwide[54]. Although, as we mentioned, agriculture is usually given a 10-12% of total greenhouse gas emissions, if we consider the energy used in agriculture and land-use changes to increase the agricultural area, these emissions can exceed 30% of the total. The 10-12% does not include the indirect emissions from agriculture, such as energy spent in fertilizer manufacturing, in the production and use of agricultural machinery, or in transport (of inputs and crops), which are included in the energy and transport industry sections. In addition, much of 18% of emissions from land-use changes also are caused by agriculture. If direct and indirect emissions are now considered, the percentage of emissions attributable to agriculture would be much higher and may exceed 30% of the total. And if we add to this the emissions generated in food processing, packaging, and distribution, the percentage of emissions from the global agri-food system is overwhelming[55].

Considering that most of the agricultural activities are made to provide humans the food that we need in order to live, changes in the consumption patterns can help to further lower greenhouse-gas emissions linked to food. Meat and dairy products have the highest global footprint of carbon, raw materials, and water per kilogram of any food. Moreover, livestock and fodder production each generate more than 3 billion tons of CO_2 equivalent. Post-farm transport and processing account for only a tiny fraction of the emissions linked to food. In conclusion, by reducing food waste and our consumption of emission-intensive food products, we can efficiently contribute to cutting the greenhouse-gas emissions of agriculture[56].

[53] B. LIN, B., VANDERMEER, J., et al., "Effects of industrial agriculture on climate change and the mitigation potential of small-scale agro-ecological farms", cit., p.1-256.
[54] BERMEJO, I., "Agricultura y cambio climático", cit.
[55] BERMEJO, I., "Agricultura y cambio climático", cit.
[56] EUROPEAN ENVIRONMENT AGENCY, *Agriculture and climate change,* cit.

3.3. Farming and animal agriculture. Industrial intensive farming.

The system on which livestock is based is one of the main causes of climate change and global warming. In fact, if the European population consumed half the meat they consume, we would be saving planet Earth from between 25% and 40% of the greenhouse emissions. All this not to mention the fact that it is an unfair system, as 800 million people are starving worldwide and, paradoxically, 2 billion people are overweight[57].

The farm animal sector is the largest anthropogenic user of land[58]. Moreover, animal agricultural production has a negative global impact on environmental integrity, community sustainability, public health, and animal welfare, which have been remained largely underestimated and underappreciated.

Even though transportation and the burning of fossil fuels have typically been regarded as the main contributors to GHG emissions and climate change, the farm animal production sector is a major threat to the environment as it contributes by an 18 %, or nearly one-fifth, to the total global of human-induced GHG emissions[59] which is more than the transport sector[60]. It is evident, then, that animal agriculture has an enormous ecological footprint, and that the meat industry emits a lot more GHGs than all cars, planes, trains, lorries, and boats together[61].

There are big impacts of growing livestock populations and intensifying production as done in our society. For instance, approximately 56 billion land animals are reared and slaughtered for human consumption annually, and livestock inventories are expected to double by 2050 and most increases will occur in the developing world[62]. As these numbers rise, especially the numbers of farm animals reared for meat, egg, and dairy production rise, their GHG emissions will also increase[63], considering both direct and indirect sources for these emissions. For instance, since

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[57] OXFAM INTERMÓN. (N.d.). *7 principales causas del cambio climático y del calentamiento global*. https://blog.oxfamintermon.org/causas-del-cambio-climatico-calentamiento-global/?gclid=Cj0KCQiAhP2BBhDdARIsAJEzXlEZJmj5yqFqJKQqI6VNTC4aOhj-meNGWik9IQyAhEYf33TzL0aenEsaArDdEALw_wcB#5_Agricultura_y_ganaderia_sistema_alimentario_no_sostenible [accessed 2021-03-06].

[58] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.578.

[59] GERBER et al., "Tackling climate change through livestock - A Global Assessment of emissions and mitigation opportunities", *FAO*, Rome 2013, http://www.fao.org/publications [accessed 2021-03-04].

[60] STEINFELD, et al., "Livestock's long shadow: environmental issues and options", *FAO*, 2006, p.1-416, http://www.fao.org/3/a0701e/a0701e.pdf [accessed 2021-03-04].

[61] OAKLEY, R. (2015). *Cows, conspiracies, and Greenpeace*. Greenpeace. https://www.greenpeace.org/international/story/7187/cows-conspiracies-and-greenpeace/ [accessed 2021-03-05].

[62] STEINFELD, et al., "Livestock's long shadow: environmental issues and options", cit.

[63] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.578.

the 1940s, the levels of methane emissions from both animals (direct emission) and their manure (indirect emission) have increased due to escalating farm animal populations[64].

It is well-known that nowadays an increasing number of animals are raised in intensive production systems which confine them in cages, crates, pens, stalls, and warehouse-like grow-out facilities. These production systems lack environmental stimuli, adequate space, or means by which to experience most natural behaviors[65]. Even with these big industrial farming activities, corporations cannot build factory farms fast enough to satisfy the population's appetite for meat[66]. Moreover, because these facilities are so industrialized and they lack land, they tend to produce more manure than can be used as fertilizer on nearby cropland, so manure is instead distributed to small, local landmass resulting in soil accumulation and runoff of phosphorus, nitrogen, and other pollutants to the atmosphere[67]. So, to sum up, each factory farm crams hundreds of animals into giant cesspools of manure that emit not only carbon dioxide, but also methane and nitrous oxide, which are the most powerful GHG[68].

Regarding CO_2 emissions, they are primarily the result of fertilizer production for feed crops, on-farm energy expenditures, feed transport, animal product processing and transport, and land-use changes[69]. Moreover, vast amounts of artificial nitrogenous fertilizer are used to grow farm animal feed, composed mainly of corn and soybeans[70]. Most of this fertilizer is produced in factories dependent on fossil fuel energy. Regarding CO_2 emissions emitted by fossil fuels expended for intensive confinement operations in industrial facilities, its energy uses differ substantially from those in smaller-scale, extensive, or pasture-based farms[71] [72].

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[64] PAUSTIAN et al., "Agriculture's Role in Greenhouse Gas Mitigation", *Center for Climate and Energy Solutions*, 2006, https://www.c2es.org/document/agricultures-role-in-greenhouse-gas-mitigation/ [accessed 2021-03-07].
[65] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.
[66] OAKLEY, R., *Cows, conspiracies, and Greenpeace*, cit.
[67] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.
[68] OAKLEY, R., *Cows, conspiracies, and Greenpeace*, cit.
[69] STEINFELD, et al., "Livestock's long shadow: environmental issues and options", cit.
[70] Feeding the global population of livestock requires at least 80% of the world's soybean crop and more than one-half of all corn, a plant whose growth is manily dependent on nitrogen-based artificial fertilizers (KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.).
[71] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.
[72] A large portion of the energy used for intensive confinement operations goes toward heating, cooling, and ventilation systems. However, more than half is expended by feed crop production, specifically to produce seed, herbicides, and pesticides, as well as the fossil fuels used to operate farm machinery in the production of feed crops (STEINFELD, et al., "Livestock's long shadow: environmental issues and options", cit)

Concerning methane, the animal agriculture sector is responsible for 35–40% of annual anthropogenic methane emissions that result from enteric fermentation[73] in ruminants and farm animal manure. Regarding N_2O, 70% of anthropogenic emissions of N_2O result from crop and animal agriculture combined. However, farm animal production, including growing feed crops, accounts for 65% of global N_2O emissions[74].

In terms of the use of land, farm animals and animal production facilities cover one-third of the planet's land surface, using more than two-thirds of all available agricultural land including the land used to grow feed crops. All in all, deforestation, land degradation, soil cultivation, and desertification[75] are responsible for CO_2 emissions from the use of land of the livestock sector[76].

In recent years, industrial livestock production has grown at twice the rate of more traditional mixed farming systems and at more than six times the rate of production based on grazing. Moreover, if we keep separating production operations from agricultural land, it will only exacerbate the environmental problems already posed by this sector. The FAO has deemed it "one of the top two or three most significant contributors to the most serious environmental problems, at every scale from local to global"[77] [78].

Finally, the impact of industrialized farming not just on climate change but on health is major. A growing proportion of the world's population consumes excess protein (especially animal products) and calories, which will lead to human health problems[79]. Mitigating the animal agriculture sector's contributions to climate change needs comprehensive and immediate action by policy makers, producers but also individual consumers. Enhanced regulation is required to hold facilities accountable for their GHG emissions and further investigations need to be done.

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[73] Enteric fermentation is a natural part of the digestive process in ruminant animals such as cattle, sheep, goats, and buffalo. Microbes in the digestive tract (rumen) decompose and ferment food, producing methane as a by-product (Climate & Clean Air Coalition. (2014). *Enteric fermentation*. https://www.ccacoalition.org/en/activity/enteric-fermentation [accessed 2021-03-08]).

[74] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.580.

[75] Desertification is degradation of land in arid, semiarid and dry subhumid areas. By reducing the amount of vegetative cover, desertification allows CO_2 to escape into the atmosphere (KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579).

[76] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.

[77] According to the FAO's estimates, CO_2 emissions from farm animal processing total several tens of millions of metric tons per year (STEINFELD, et al., "Livestock's long shadow: environmental issues and options", cit.)

[78] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.

[79] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.580.

4. MAIN CONSEQUENCES OF CLIMATE CHANGE

If there is no consensus on the causes of climate change, much less there is about the effects it can have on life on the planet. However, many impacts of global warming are already detectable, and the following explanations will be based on the U.S. Environmental Protection Agency Report[80] about them.

4.1. The meltdown of ice and snow.

According to the U.S. Environmental Protection Agency[81], on the Earth's surface, there are many forms of snow and ice: seas, lakes, river ice, snow covers, glaciers, ice caps, ice sheets, and frozen ground. Due to climate change, the Earth's snow can be easily altered as it rapidly changes between solid and liquid states in response to minor changes in temperature. However, ice-covered areas are being altered as well as a response to climate change.

Reduced snowfall and less snow cover on the ground diminishes the beneficial insulating effects of snow for vegetation and wildlife. It also affects water supplies, transportation, cultural practices, travel, and recreation for millions of people.

As snow and ice influence air temperatures, sea level, ocean currents, and storm patterns, changing climate conditions have worldwide implications. For instance, melting ice sheets in Greenland and Antarctica adds fresh water to the ocean, which increases sea level and possibly changes ocean circulation that is driven by differences in temperature and salinity. Moreover, snow and ice reflect more sunlight than open water or bare ground due to their light color, so a reduction in snow cover and ice causes the Earth's surface to absorb more energy from the sun and become warmer.

For communities in Arctic regions, reduced sea ice could increase coastal erosion and exposure to storms, threatening homes and property, while thawing ground could damage roads and buildings and accelerate erosion.

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[80] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", Fourth Edition, 2016, p.1-92, https://www.epa.gov/sites/production/files/2016-08/documents/climate_indicators_2016.pdf [accessed 2021-03-09].

[81] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 39 y ss.

4.2. Raise in sea levels.

As suggested above, if the temperature of the Earth changes, so does sea level. Changes in the volume of water and ice on land, *i.e.*, glaciers and ice sheets, can increase or decrease the volume of water in the ocean. As the water warms, it expands slightly and rising sea level inundates low-lying wetlands and dry land, erodes shorelines, contributes to coastal flooding, and increases the flow of salt water into estuaries and nearby groundwater aquifers. Moreover, a higher sea level makes coastal infrastructure more vulnerable to damage from storms, as there is a bigger likelihood of flooding from higher storm surges[82].

4.3. The rise in global temperature

Warmer temperatures are one of the most direct signs that the climate is changing. Concentrations of heat-trapping GHGs are increasing in the Earth's atmosphere and average temperatures at the Earth's surface are increasing and are expected to continue rising. A rise in global average temperature causes widespread changes in weather patterns (wind patterns, ocean currents...). Scientific studies indicate that extreme weather events such as heat waves and large storms are likely to become more frequent or more intense with human-induced climate change[83].

Average global temperatures have risen considerably, and the IPCC predicts increases of 1.8–3.9°C (3.2–7.1°F) by 2100, as it has been mentioned in the climate change general overview above. During the last century, average temperatures rose only 0.06°C (0.12°F) per decade, while these new temperature rises are much greater. Since the mid-1970s, the rate of increase in temperature rises has tripled and the IPCC's latest report warns that climate change could lead to some impacts that are abrupt or irreversible[84].

Long-term climate changes can directly or indirectly affect many aspects of society in many disruptive ways. For instance, more frequent and intense extreme heat events (for instance, heat waves) can increase illnesses and deaths, especially among vulnerable populations, and damage some crops. Intense storms can damage property, cause loss of life and population displacement and temporarily disrupt essential services such as transportation, telecommunications, energy, and water supplies[85].

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[82] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 39 y ss.
[83] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 18 y ss.
[84] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.578.
[85] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 18 y ss.

4.4. Increase in droughts.

According to the U.S. Environmental Protection Agency[86], meteorologists define drought as a prolonged period of dry weather caused by a lack of precipitation that results in a serious water shortage for some activity, population, or ecological system. It can also be understood as an extended imbalance between precipitation and evaporation, *i.e.*, average temperatures have risen due to climate change, evaporation has increased, making more water available in the air for precipitation, but also contributing to drying over some land areas and less moisture in the soil.

According to the IPCC, many areas already suffering from drought will become drier, exacerbating the risks of both hunger and disease[87].

Drought conditions can negatively affect agriculture, water supplies, energy production, and many other aspects of society. Thus, lower streamflow and groundwater levels harm plants and animals, and dried-out vegetation increases the risk of wildfires.

4.5. Biological consequences. Degradation of ecosystems

Ecosystems provide humans with food, clean water, and a variety of other services that can be affected by climate change[88]. Currently, there are changes in wildfires, streams, and lakes, bird migration patterns, fish and shellfish populations, and plant growth.

Changes in the Earth's climate affect ecosystems by altering the water cycle, habitats, animal behavior, and the timing of natural processes like flower blooms. These changes disrupt the functioning of ecosystems and increase the risk of harm or even extinction for some species.

For instance, wildfires occur naturally, but more frequent and more intense fires can significantly disrupt ecosystems, damage property, put people and communities at risk, and create air pollution problems even far away from the source.

Plants and animals have adapted to environmental change for millions of years, but the climate changes experienced now could require adaptation on larger and faster scales than current species have successfully achieved in the past, increasing the risk of extinction or severe disruption for many species, at the same time that benefits a few opportunistic species of fast scattering. However, responses from organisms and ecosystems to climate change are so varied and complex

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[86] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 28.
[87] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.580.
[88] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 71 y ss.

as the ecosystems themselves. Each species responds differently, and their responses affect the rest of the ecosystem components. Nevertheless, scientists agree on the tendency of species to move to higher altitudes and towards the poles[89].

Added to that, the effects of climate change are linked to the impacts that our species has had over the biosphere, among which habitat deterioration and overexploitation of species took place[90].

As a detailed example of the biological consequences, the anticipation of springs will be analyzed below.

4.5.1. Anticipation of springs

Phenology is the study of important seasonal events and their timing, such as flower blooms and animal migration[91]. These events are influenced by a combination of environmental factors, including temperature, light, rainfall, and humidity. Thus, they have a close connection with climate and its timing can be used as an indicator of the sensitivity of ecological processes to climate change. Two particularly useful indicators are the first leaf dates and the first bloom dates of lilacs and honeysuckles in spring. Scientists have high confidence that the earlier arrival of spring events is linked to recent warming trends in the global climate[92].

Temperature is the main driver of many developmental processes in biology. The rates of chemical reactions are temperature-dependent and generally increase with increasing temperature. In many cases, higher temperatures have sped up plant development. Moreover, in water-limited systems where plants enter dormant stages or die when soil water is depleted, changes in precipitation patterns are expected to modify the annual cycle of plant activity.

It is clear and documented that an advance in spring leaf bud burst and flowering dates in middle and higher latitudes is happening and that could well be an effect of concurrent anthropogenic climate change and associated increasing temperatures[93].

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[89] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.382.
[90] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.382.
[91] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 82.
[92] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 82.
[93] BADECK, F. W., BONDEAU, A., BÖTTCHER, K., DOKTOR, D., LUCHT, W., SCHABER, J., & SITCH, S., "Responses of spring phenology to climate change", *New Phycologist*, Vol.162, Issue 2 (2004), p. 295-309, https://doi.org/10.1111/j.1469-8137.2004.01059.x [accessed 03/03/2021].

4.6. Increase in infectious diseases.

Climate changes affect the average weather conditions to which humans are accustomed. These changes may result in multiple threats to our health and welfare. Climate change affects different regions and sectors of society depending not only on the sensitivity of those systems to climate change but also on their ability to adapt to or cope with climate change[94]. Populations of particular concern include the poor, children, the elderly, those already in poor health, the disabled, and indigenous populations.

The life cycles and transmission of many infectious agents—including those causing diseases in humans, agricultural systems, and free-living animals and plants—are inextricably tied to climate and they respond to its changes[95]. Global temperature shifts may also hasten the speed at which infectious diseases emerge and remerge. According to the WHO, the biggest risk factor for the emerging of disease is environmental degradation by humans, particularly deforestation, logging, and urbanization[96].

Climate change has already increased the occurrence of diseases in some natural and agricultural systems although, in many cases, outcomes depend on the form of climate change and details of the host-pathogen system[97]. Moreover, over the past decade, climate warming has caused profound and complex changes in the prevalence or severity of some infectious diseases even though for human diseases, vector-control, antimicrobial treatments, and infrastructural changes can mask climate effects[98].

All that said, predicting the consequences of climate change for infectious disease severity and distributions is a persistent and much-controverted challenge.

4.7. Others

Changes in the Earth's climate affect most aspects of life in general. Public health, agriculture, water supplies, energy production and use, land use, and development recreation...

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[94] U.S. ENVIRONMENTAL PROTECTION AGENCY, "Climate Change Indicators in the United States", cit., p. 59.
[95] ALTIZER, S., OSTFELD, R. S., JOHNSON, P. T. J., KUTZ, S., & HARVELL, C. D., "Climate change and infectious diseases: from evidence to a predictive framework", *Science*, Vol.341, Issue 6145 (2013), p. 514-519, https://doi.org/10.1126/science.1239401 [accessed 2021-03-10].
[96] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.580.
[97] ALTIZER, S., OSTFELD, R. S., JOHNSON, P. T. J., KUTZ, S., & HARVELL, C. D., "Climate change and infectious diseases", cit., p.514.
[98] ALTIZER, S., OSTFELD, R. S., JOHNSON, P. T. J., KUTZ, S., & HARVELL, C. D., "Climate change and infectious diseases", cit., p.518.

Ban Ki-moon, the eighth United Nations Secretary-General, has noted that natural disasters, droughts, and other changes brought about by global warming "are likely to become a major driver of war and conflict"[99]. But this is not something that we were not aware of already, as it is well-known that war and conflict are already happening nowadays due to climate change in many areas of society.

[99] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.580.

5. REGENERATIVE AGRICULTURE: A SOLUTION FOR CLIMATE CHANGE.

Climate change is having drastic consequences for life on Earth, but there is a lot of controversy about what to do about it. As stated above, if there is no agreement by the scientific community about the causes of climate change, less there is about its solutions and mitigation. However, it has been shown that one of the biggest contributors to global warming and climate change is the amount of greenhouse gas emissions by human activities. Thus, it is logical to think that a reduction of the emission of gases in the atmosphere by humans could contribute to an improvement of the climate situation.

Mitigation of climate change involves reducing the flow of heat-trapping GHGs into the atmosphere. This can be done either by reducing sources of these gases such as the burning of fossil fuels for electricity, heat, or transport, or by enhancing the "sinks" that accumulate and store these gases such as the oceans, forests, and soil[100]. As stated in the report on Mitigation of Climate Change from the United Nations Intergovernmental Panel on Climate Change, the goal is to stabilize greenhouse gas levels in a timeframe sufficient to allow ecosystems to adapt naturally to climate change, ensure that food production is not threatened, and to enable economic development to proceed sustainably[101].

Countries around the world acknowledged the imperative to act on climate change with the Paris Agreement in 2015, making pledges to reduce greenhouse gas pollution. However, the most polluting countries, *i.e.*, The U.S., China, and India did not agree on the initiatives that were being proposed, so many solutions that already exist nowadays could not be implemented. These solutions hinge on humans changing the way they behave, produce, and consume.

While halting new greenhouse gas emissions is critical, scientists have also emphasized that we need to extract existing carbon dioxide from the atmosphere. Planting trees, restoring seagrasses, and boosting the use of agricultural cover crops could help clean up significant amounts of carbon dioxide and store them in the biomass and soil[102].

In line with all the exposed above and due to the purposes of this study, we will analyze one potential solution to climate change that could not only stop it but reverse it as it would reabsorb

[100] NASA. (N.d.). Mitigation and Adaptation | Solutions. *Global Climate Change: Vital Signs of the Planet.* https://climate.nasa.gov/solutions/adaptation-mitigation/ [accessed 2021-03-15].
[101] NASA, Mitigation and Adaptation | Solutions, cit.
[102] NASA, Mitigation and Adaptation | Solutions, cit.

a huge quantity of greenhouse gas emissions from the atmosphere to the soil. This solution is regenerative agriculture.

5.1. Regenerative agriculture. A general overview.

Nowadays, regenerative agriculture does not have a comprehensively described scientific definition[103].

Terra Genesis International[104] defines it as a system of farming principles and practices that increases biodiversity, enriches soils, improves watersheds, and enhances ecosystem services. It aims to capture carbon in soil and aboveground biomass, reversing current global trends of atmospheric accumulation of GHGs. At the same time, it offers increased yields, resilience to climate instability, and higher health and vitality for farming and ranching communities. It is "an approach to farming that uses soil conservation as the entry point to regenerate and contribute to multiple provisioning, regulating and supporting ecosystem services, with the objective that this will enhance not only the environment but also the social and economic dimensions of sustainable food production[105]".

It is well known, as we have mentioned before, that our food production and consumption habits are unsustainable and very dangerous not only for our health but for their impact on the environment. With regenerative agriculture, the farming approach is changed in a way that new production habits may also lead to new consumption habits and vice versa.

This links to Kiss the Ground[106]'s theory of change, which states that new views lead to new actions that create new outcomes. This section will mainly focus on its approach to present the view on regeneration concerning agriculture, the way we grow our food, fiber, and fuel. In the words of this organization, if regenerative means: "renewal, restoration, and growth of cells, organisms, and ecosystems", or "renewal or restoration of a body, bodily part, or biological

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[103] SCHREEFEL, L. et al., "Regenerative agriculture – the soil is the base", *Global Food Security*, Vol.26 (2020), p.1, https://doi.org/10.1016/j.gfs.2020.100404 [accessed 10/03/2021].
[104] TERRA GENESIS INTERNATIONAL. (N.d.). *Regenerative agriculture.* http://www.regenerativeagriculturedefinition.com/ [accessed 10/03/2021].
[105] SCHREEFEL, L. et al., "Regenerative agriculture", cit., p.5.
[106] Kiss the Ground is a non-profit Organization born in California, that started studying how healthy soil microbes, working with plants and animals, can sequester carbon from the atmosphere and push for the "regeneration" of the ecosystems and the planet in general (KISS THE GROUND. (N.d.). https://kisstheground.com/ [accessed 2021-03-18]).
Kiss the Ground is also the name of the ground-breaking film, winner of 45 awards now, narrated and featured by Woody Harrelson, that reveals the first viable solution to our climate crisis: the regeneration of the world's soils that can rapidly stabilize Earth's climate, restore lost ecosystems and create abundant food supplies (KISS THE GROUND FILM. (2020).
Kiss the Ground Film | Official Website (kisstheground movie.com) [accessed 2021-03-18]).

system (as in a forest) after injury or as a normal process," then regenerative agriculture is agriculture that is doing just that. On the contrary, when a system of agriculture is disrupting, destroying, or halting the process of photosynthesis in the plant and/or the symbiotic microbial processes within and around the plant, it is degenerative agriculture, as well as if the biodiversity in the agricultural ecosystem is decreasing or if we are losing topsoil or increasing desertification[107]. Fortunately, nature tends to be regenerative and to increase ecosystem carrying capacity[108] over time. The more biodiversity an ecosystem has, the better the resilience, *i.e.*, the capacity to survive, recover and adapt to new configurations. We are told that life is all about competition and survival of the fittest, but this is usually only true when using a narrow perspective. If we use a whole systems perspective, the observation is that life is also very cooperative, mutualistic, and symbiotic. The more cooperation and biodiversity, the better the chances of the ecosystem and species to survive[109].

In fact, as an example of how a disruptive behavior that leads to a lack of diversity is not beneficial, there are species that disrupt an ecosystem so severely that it makes it inhospitable for them, so ultimately, they also die. We do not want to be this species. However, as paradoxical as it seems, it is true, and human beings are destroying the Earth and themselves with their practices and lifestyle.

The system that makes nature regenerative on land is the symbiotic relationship between photosynthesizing plants and soil microorganisms, as together they create soil and biomass. This is the reason why life on Earth can restore itself when harmed or why ecosystems can naturally regenerate. This is the process that pulls carbon from the CO_2 in the atmosphere and converts it into everything alive, making life, as we know it, possible[110].

Regenerative agriculture can be the first viable solution to climate change through the regeneration of the world's soils, resulting in a rapid stabilization of the Earth's climate, a restoration of lost ecosystems, and a way to create abundant food supplies[111]. This is possible by drawing down atmospheric carbon to all living things, plants and animals.

Soil is the missing piece of the climate puzzle. If we put it into the equation, we do not have to disrupt the ecosystems and environment anymore, but the opposite. We bring it back to its natural state and process while we try to amend the damage that has already been done.

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[107] KISS THE GROUND. (N.d.). *Soil Science Resources*. https://kisstheground.com/soil-science/
[108] The carrying capacity is the greatest amount of species biodiversity, population, and mass that can continue to survive in a given environment (KISS THE GROUND, *Soil Science Resources,* cit.).
[109] KISS THE GROUND, *Soil Science Resources,* cit.
[110] KISS THE GROUND, *Soil Science Resources,* cit.
[111] KISS THE GROUND FILM, cit.

5.2. Why is regenerative agriculture a good solution to climate change?

It is a general truth that to mitigate climate, we need to reduce the GHGs in the atmosphere. If we pay attention to the global food system, we find out that it currently releases about 25% of annual anthropogenic greenhouse gas (GHG) emissions, causes about one-third of terrestrial acidification, and is responsible for most of the global eutrophication of surface waters[112].

The problem is that if our food system continues as it is nowadays, *i.e*., using synthetic pesticides, artificial fertilizers, fossil fuels, and producing food waste, the carrying capacity of the planet will be surpassed. For this reason, we need to produce enough safe and nutritious food for a growing and wealthier population without destroying the planet with it. Of course, this challenge has led to new narratives for sustainable agriculture[113] and here it is where regenerative agriculture comes into the equation. As explained above, the current model of agriculture and intensive livestock is one of the main causes of climate change due to the deforestation associated with it, the burning of fossil fuels, the large-scale monocrops, cruel livestock production, etc.

As paradoxical as it seems, the solution can be found in the same problem, which is not agriculture or farming itself, but how its activities are performed. For that, we must move from degenerative and detrimental agriculture to regenerative agriculture and farming systems.

Regenerative agriculture is the most viable solution nowadays, as it considers the missing piece: the soil under our feet. This new variable in the equation turns around the perspective of carbon from bad to necessary when used properly. Thus, the problem and the solution are simply a matter of balance.

We are all carbon-based lifeforms, *i.e.*, carbon is the building block of life, everything alive is made of it. It is the main component of sugars, proteins, fats, DNA, muscle tissue, and almost everything in our body and other life forms on the planet. Unlike aerosols or other toxic chemicals, carbon is not a pollutant, but too much of it in the wrong place can be highly destabilizing[114].

Soil, together with sunlight, air, and water provides the basis for life today. It is a complex mix of minerals, air, water, and countless microorganisms that comes in many types. It is what allows us to grow our food, filter water, and is host to the greatest concentration of biomass anywhere on the planet.

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[112] SCHREEFEL, L. et al., "Regenerative agriculture", cit., p.1.
[113] SCHREEFEL, L. et al., "Regenerative agriculture", cit., p.1.
[114] KISS THE GROUND. (N.d.) *The soil story*. https://kisstheground.com/thesoilstory/#top [accessed 11/03/2021].

Carbon is stored in five major pools: atmosphere, biosphere, oceans, soil, and fossil. It flows between these pools in an exchange called the carbon cycle. Any change in the cycle that shifts carbon out of one pool puts more carbon in another pool.

About 500 million years ago, when plants appeared on land, carbon began to cycle in balance between these pools, a balance that allowed for life as we know it to evolve[115]. However, humans figured how to extract carbon from the fossil pool and burn it for energy, disrupting that balance. If that was not already enough disruption, the way we began to manage land and do agriculture moved (and still does) even more carbon from the soil and biosphere into the atmosphere[116]. In fact, the human being has moved 534 gigatons of carbon dioxide into the atmosphere which, of course, is heating the planet and destabilizing the climate. Moreover, the oceans have absorbed a lot of this excess carbon, which is resulting in ocean acidification and accelerating a mass extinction of sea life.

But what if we could find a place to store the excess carbon that we have emitted? This is where the soil comes into play. There is an ancient "technology" that can remove the carbon from the atmosphere, and it's got 500 million years of research and development behind it: plants, with sunlight and water, perform the photosynthesis[117], they pull in carbon from the air and turn it into carbohydrates, sugars, which build the biosphere and the soils. Then they pump some of those sugars through the roots down to Earth, to feed microorganisms who use that carbon to build soil. This way, carbon has been already moved from the air to the soil that now stores it.

Scientists have recently discovered that applying a thin layer of compose (which means putting a little bit of carbon back into the surface) sets up an ongoing feedback loop that brings more and more carbon into the soil each year. Along with other regenerative practices that will be explained below (not tilling the soil, planting trees, cover crops, planned grazing…), gigatons of soil carbon can be built and retained.

This is carbon farming, regenerative agriculture. Unlike more carbon in the atmosphere, more carbon in the ground is good for the planet as it makes healthy soil that is nutrient-rich, full of

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[115] Over the long term, the cycling of carbon between the five pools maintains a balance that prevents all of Earth's carbon from entering the atmosphere, as it happens on Venus, or from being stored entirely in rocks. This balance allows the Earth to have a relatively stable and livable temperature. (KISS THE GROUND, *The soil story*, cit.). This is how important this cycle is.

[116] Carbon makes up 50% of soil organic matter (SOM) in soil. SOM is vital to healthy soils but most modern agricultural operations focus on managing nitrogen, phosphorus and potassium and ignore carbon. The soil is the largest storehouse of carbon on land. Yet, 50% to 70% of the world's cultivated soils lost their original carbon stock when soils were exposed to air and the carbon oxidized to become CO_2 (KISS THE GROUND, *The soil story*, cit.).

[117] Before plants evolved on land, the Earth was much hotter because there was much more carbon in the atmosphere. The evolutionary development of plants fixing carbon through photosynthesis is complex and occurred over a long period of time (KISS THE GROUND, *The soil story*, cit.).

life, and holds way more water. This means more nutritious food and crops that are more resilient in the face of drought. That is good news for farmers, families, and everyone that eats[118]. The way we grow our food, fibers, and fuels, either puts carbon up into the atmosphere or pulls it down into the ground. The regeneration of soil is the task of our generation. Our health, the health of our soils, and the health of our planet are one and the same.

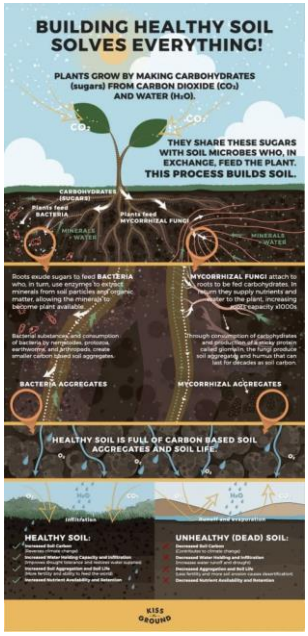

Figure 8. The process to build healthy soil. Plants use water (H_2O) from the soil and carbon dioxide (CO_2) from the air and recombine them to form carbohydrates (COH) and oxygen (O_2). These carbohydrates form the basis of the food chain for humans, animals, and the soil ecosystem. Living plant roots actively exude sugars, amino acids, and other compounds into the soil to feed soil organisms and these, in return, provide nutrients to the plants and build the soil. Microbes in the soil create enzymes to break down existing organic matter or mineral soil, making nutrients more available to the plant, and they use these carbohydrates (sugars) to build carbon glues that aggregate the soil particles so air and water can move through the soil system[119].

5.3. Fundamentals of soil health.

Every farm is different. Yet, there are several basic principles that farmers use to build healthy soil.

[118] The nutrients in our diets come from plants growing in soil or from animals that eat plants. As plants' roots absorb water, they also take in nutrients dissolved in the water (nitrogen, calcium, iron, and others). The healthier the soil, the more nutrients are present and available for the plants. At the same time, the less carbon in the soil, the less available minerals (KISS THE GROUND, *The soil story*, cit.)
[119] (KISS THE GROUND, *The soil story*, cit.)

5.3.1. Less disturbance

Most of our farming practices damage the health of the soil over time. The less disturbance principle is based on avoiding plowing[120] the soil and abstaining from using harmful chemical amendments because such practices make it difficult for a complex soil ecosystem to thrive. All regenerative soil practices agree that farming should minimize or eliminate tillage[121], which is the process of turning over and breaking up the soil[122].

Tilling kills and destroys critical mycorrhizal fungal networks[123], pulverizes soil aggregates, which increases soil erosion from wind and water and decreases the rate that water can be absorbed into the soil. It also brings stored soil carbon to the surface to be oxidized, disturbs soil organisms' habitat, and increases evaporation rates[124].

On the contrary, no-tilling means that the farmer has left the prior crop's residue and the mass of plants on the soil surface, with the roots still in the ground, and planted the new crop directly into the soil without tilling. This protects mycorrhizal fungi and all the soil ecosystem, increases water retention and infiltration, reduces erosion, feeds microbial communities and life in the soil, and allows more carbon to stay in the soil[125].

5.3.2. Living roots

Keeping living roots in the ground during the whole year or for as long as possible provides a steady source of food for organisms in the soil (as we explained above, they feed on the sugars that come from the roots of the plants). In turn, soil microorganisms help prevent soil erosion, increase water infiltration rates, and provide plants with key nutrients[126].

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[120] To plow the soil means to dig into the Earth with a large farming tool to make the Earth ready for planting (CAMBRIDGE ENGLISH DICTIONARY, (N.d.). *Plow*. https://dictionary.cambridge.org/dictionary/english/plow [accessed 12/03/2021]).
[121] MCGUIRE, A. (2018). *Regenerative Agriculture: Solid Principles, Extraordinary Claims*. Center for Sustaining Agriculture and Natural Resources (CSANR) | Washington State University. https://csanr.wsu.edu/regen-ag-solid-principles-extraordinary-claims/ [accessed 2021-03-20].
[122] KISS THE GROUND, *The soil story*, cit.
[123] Fungi are responsible for producing acids and enzymes that make nutrients available to plants, creating carbon-based soil aggregates that hold 20x their weight in water, decomposing cellulose and lignin, allowing plants to share resources, helping plants fight off disease and pests, and are a key component of a regenerative healthy soil ecosystem (KISS THE GROUND, *The soil story*, cit.).
[124] KISS THE GROUND, *The soil story*, cit.
[125] KISS THE GROUND, *The soil story*, cit.
[126] KISS THE GROUND, *The soil story*, cit.

5.3.3. Soil armor

Keeping the soil covered with living plants or trampled/dead plant material reduces erosion and helps lower soil temperatures[127]. You cannot build soil while it is blowing or washing away. In fact, by reducing the amount of vegetative cover, desertification allows CO_2 to escape into the atmosphere[128] and accumulates in the air, contributing to global warming and climate change.

5.3.4. Increased biodiversity

Unless it has been done by industrial agriculture, growing a diversity of plants helps cultivate nutrient-dense soil, increase soil carbon, and reduce the risk of pests and diseases[129]. This principle is shared by all the regenerative agriculture versions and conservation agriculture[130].

5.3.5. Animal integration and planned grazing.

As we may know, about 80% of agricultural land is used for raising livestock and our lack of proper grazing management is desertifying the land, making it less productive[131].

As traditionally done, it is necessary to include animals in farming systems as it closes the nutrient loop and reduces the need for imported fertilizers. However, deciding which are the right species of animals to incorporate depends on each farm's unique ecosystem and climate. In all versions of regenerative agriculture, the animal impact is crucial to making regenerative agriculture work, and the main way to get it is through planned grazing, which refers to the process of moving livestock from pasture to pasture at the right time, allowing the animals to fertilize the land, disturb and aerate the soil slightly, and trigger plants to come back with stronger growth. In other words, this process of grazing management focuses on the timing and duration of animal grazing that can rehabilitate landscapes on a large scale. Nevertheless, it is important to move them before they trample the land or begin to eat too close to the ground and impede plant growth. If done correctly, grazing can increase biodiversity and improve levels of soil organic matter. It also restores water systems and land, brings healthier animals as well as healthier food, healthy soil, and increases farmer prosperity[132].

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[127] KISS THE GROUND, *The soil story*, cit.
[128] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.579.
[129] KISS THE GROUND, *The soil story*, cit.
[130] MCGUIRE, A. *Regenerative Agriculture: Solid Principles, Extraordinary Claims*, cit.
[131] KISS THE GROUND, *The soil story*, cit.
[132] KISS THE GROUND. *The soil story*, cit.

As demonstrating facts, farmers who carefully manage and move their herds have seen perennial streams that once went dry return. Moreover, on farms that utilize intensive 1-2 day pasture rotations, the capacity of the land to support cattle has increased by 200 to 300 %. Native grasses re-establish themselves and farmers stop having to till, sow, and weed, which dramatically decreases their fuel and equipment costs. The behavior of the cattle also changes and begin eating protein-rich weeds in addition to their typical diet of grasses[133].

5.3.6. Context

No two farms are alike. Thus, context is key. Some have brittle environments, some have moist ones, they have different crops and livestock, from no funds to extensive funds... To know what is the best way to go about regenerating land, a holistic framework is necessary to successfully transition to a regenerative approach.

5.4. Farming, livestock, and meat industry

Animals are an essential part of the nutrient cycle and managing them properly in our agricultural systems is critical for restoring soils and balancing the climate.

However, the industrial food system has removed animals from farmland and housed them in Confined Animal Feeding Operations (hereinafter, CAFOs). The raising and slaughtering of livestock in this conventional model break the nutrient cycle, create pollution, and contributes to global warming. This type of industrialized meat production has severe consequences for the planet. For instance, the land is being deforested to support herds of grazing animals, disrupting the natural ecosystem. Moreover, CAFO animals are often stressed and very unhealthy, most of them beings fed antibiotics and growth hormones to keep them alive. Keep in mind that this is what we afterward eat. At the same time, CAFOs concentrate animal excrement in large pools that release large amounts of ammonia, which is of public health concern, and methane, into the air. Linked to the monocrops and industrial agriculture, massive, industrialized corn and soybean fields are needed to produce the food to feed these animals, causing a degradation of the land and releasing carbon from the soil. From a humanitarian point of view, mass-scale slaughter is often inhumane and unsanitary. Moreover, the transportation and slaughter of animals and the packaging and delivery of meat have high fossil fuel costs, which also contribute to the CO_2 emissions in the atmosphere and climate change in general.

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[133] MARTIN, A., TUCKER L., WOJCIK B., CHIARTAS J., SMITH D., "#Eat4climate. Purchasing guide", cit., p. 22, https://kisstheground.com/purchasingguide/

This is the reason why it is so important to start raising animals differently, allowing them to contribute to the restoration of landscapes, regeneration of the land, the building of soil, and carbon sequestration, through regenerative meet production methods such as planned grazing. This way, animals are moved across the land at carefully timed intervals, helping to restore native grasslands, spurring new plant growth, and fertilizing the soil. As land is now better stimulated and fertilized, biodiversity increases, soil health improves, and carbon is sequestered. Animals will also be stronger and healthier, moving according to their natural rhythms and eating the kinds of food they evolved to eat, so our food and health will also improve.

We are what we eat. If we understand how much the massive production of meat detriments the land and the climate, we also understand that this system cannot be held for much longer. Thus, it is important to buy meat from ranchers and farmers who are utilizing regenerative models of meat production, support businesses that are restoring soils and native grasslands, taking good care of their animals, and sequestering carbon through healthy soil practices and holistic management. If one aligns with that, naturally the consumption of meat is less.

In fact, if 50% of the world's population reduced meat consumption overall, an estimated 26.7 gigatons of emissions could be avoided from dietary change alone. If we would avoid deforestation from land-use change, an additional 39.3 gigatons of emissions could be avoided, making healthy, plant-rich diets one of the most impactful tools to fight global warming[134].

As quick facts, most industrial farms cram their birds (mostly chickens and turkeys) into crowded, dark spaces and feed them industrial soy to provide them with large amounts of cheap protein[135]. However, industrially produced soy is destructive to the soil because it requires heavy tilling and pesticide use. Goats eat everything; they are adept at clearing overgrown land to get it ready for planting and clearing brush to help prevent fires. Pigs, on their side, are great at eating fruits and nuts that fall to the forest floor and help till and aerate the soil with their feet. They can be moved around a forested area to help fertilize the soil. Cows, sheep, chickens, and turkeys can also be raised in forested areas[136]. Now, if we raise animals in a way that mimics nature instead of that in a way that takes them away from it, there are more opportunities for carbon to be drawn out of

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[134] MARTIN, A., TUCKER L., WOJCIK B., CHIARTAS J., SMITH D., "#Eat4climate. Purchasing guide", cit., p.16.

[135] Cattle confined in feedlots or in intensive confinement dairy operations are fed an unnatural diet of concentrated high-protein feed consisting of corn and soybeans. Cattle may gain weight rapidly when fed this diet, but it can cause a range of illnesses and lead to increased methane emissions. In contrast, cattle raised on pasture, eating a more natural, low-energy diet composed of grasses and other forages, produce manure with about half of the potential to generate methane (KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.580).

[136] MARTIN, A., TUCKER L., WOJCIK B., CHIARTAS J., SMITH D., "#Eat4climate. Purchasing guide", cit., p.24 ff.

the atmosphere through photosynthesis, and for healthy soil to store it. If they are raised in cages, they cannot contribute to the natural regenerative cycle.

Indeed, organic farming has the potential to reduce GHG emissions and sequester carbon. Also, raising cattle for beef organically on grass, in contrast to fattening confined cattle on concentrated feed, may emit 40% less GHGs and consume 85% less energy than conventionally produced beef[137]. It is clear that a change needs to happen.

[137] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.581.

6. CASE STUDY: CAN CONSUMERS CHANGE THEIR HABITS FOR THE BENEFIT OF THE PLANET? A CONDUCTED SURVEY.

6.1. Methodology

As well-known as it is that the ongoing food system is incompatible with decent care of the environment, it is urgent that not only global institutional action is taken but also individual action of consumers, which actively participate in the food system. For this reason, survey-type research was conducted to analyze the awareness of the consumers regarding the current climate situation and its relationship with both regenerative agriculture and their food habits, *i.e.*, their level of knowledge in both the climate situation and the impact of their food habits in the environment, through very specific questions presented on the survey. Ultimately, the idea was to find out if the current situation envisions a potential change towards better food habits and consequently a preserved environment, or the opposite.

6.2. Participants

The population analyzed in this statistical study were the consumers around the world in 2021. The survey was sent through different social networks (WhatsApp, Instagram…) to people around the world, obtaining a sample of 328 people that completed the whole survey. Those who did not finish the survey were not considered in the analysis. The participants were from different parts of the world, they had different ages, they came from different backgrounds and they also had different levels of income and education. The more diverse the sample was, the most accurate representation of reality the analysis would achieve. In that regard, the sociodemographic characteristics of the surveyed participants were summarized in the following table, indicating the number of consumers associated with each subgroup and their percentage related to the total of observations:

Table 1. Socio-Demographic Characteristics of the Study Sample (N=328)

	n	%
Gender	321	100.00%
Male	177	55.14%
Female	139	43.30%
Non-binary	2	0.62%
Others	0	0.00%
Prefer not to say	3	0.93%

Age	325	100%
0 - 30	171	52.62%
31 - 60	98	30.15%
>61	56	17.23%
Continent	327	100.00%
Europe	301	92.05%
Asia	2	0.61%
Africa	20	6.12%
North America	4	1.22%
South America	0	0.00%
Country	324	100.00%
Spain	29	8.95%
Catalonia	229	70.68%
Germany	4	1.23%
Ireland	2	0.62%
England	11	3.40%
Belgium	1	0.31%
Italy	3	0.93%
Taiwan	1	0.31%
South Africa	20	6.17%
Luxemburg	1	0.31%
Rumania	1	0.31%
Netherlands	3	0.93%
Poland	4	1.23%
Austria	8	2.47%
Mexico	1	0.31%
Russia	2	0.62%
Switzerland	1	0.31%
United States	3	0.93%
Location Type	326	100.00%
Rural Village	55	16.87%
City	270	82.82%
Nomad	1	0.31%
Monthly net wage	323	100.00%
0 - 600 euros / 0 - 728 dollars / 0 - 10519 Rands	89	27.55%

601 - 1200 euros / 729 - 1456 dollars / 10520 - 21038 Rands	68	21.05%
1201 - 1800 euros / 1457 dollars - 2184 dollars / 21039 - 31558 Rands	53	16.41%
1801 - 2200 euros / 2185 - 2670 dollars / 31559 - 38571 Rands	54	16.72%
2201 - 3000 euros / 2671 - 3640 dollars / 38572 - 52597 Rands	36	11.15%
3001 - 4000 euros / 3641 - 4854 dollars / 52598 - 70129 Rands	16	4.95%
+ 4000 euros / + 4855 dollars / + 70130 Rands	7	2.17%
Level of education	324	100.00%
Primary/Elementary School	5	1.54%
Secondary School / High School	22	6.79%
Baccalaureate / General Certificate of Education (GCE)	37	11.42%
Vocational Education Training (VET)	15	4.63%
Certificate of Higher Education (HNC)	40	12.35%
University Degree	128	39.51%
Professional/Vocational training	12	3.70%
Master's Degree (M)	54	16.67%
Doctorate (PhD)	6	1.85%
Private formation	5	1.54%

6.3. Data Collection

The questionnaire used for the data collection constituted four sections. The first one aimed to collect the basic sociodemographic characteristics of each consumer through 10 questions, some of which were open-ended, and others closed-ended, as seen in the table above. The second part was based on finding out if the consumers had a high or low level of self-care, so to know if they individually found health to be an important aspect of their lives or not. The third section focused on analyzing the level of awareness of the causes, consequences, and solutions of climate change through mostly multiple-choice options and some open answers too. Regenerative agriculture questions were also part of this section to analyze if the sample population really knew about it and its potential for mitigating and reversing climate change. The items of this section were formed via an extensive literature review related to the causes, consequences, and solutions to climate change. The fourth section consisted of observing the eating habits of the consumers and finding out to what extent they would be willing to change these habits in favor of climate change. For this, questions about the level of commitment to the environment were asked, as well as an exhaustive set of questions regarding their willingness to change their food habits depending on various variables such as the quality of the product, its price, the possibility of online purchase, among others. Finally, as it is well known that the meat industry as it performs nowadays is one

of the most damaging and polluting industries of all, a couple of questions were asked about their meat-eating habits and their willingness to change at least to organic meat instead of conventional meat. All of these questions have been summarized in annex 1 along with their basic statistical descriptive tools.

6.4. Instrument

Different tools were used in the questionnaire. Some questions used a multiple-choice option (such as which are the causes, consequences, or solutions of climate change), open answers, or simply a single-choice option (such as how often you exercise, or what is your meat consumption, among others). Some other questions such as the level of awareness of the causes, consequences, solutions of climate change, engagement with the environment, or the level of self-health care were formed through a Likert[138] scale, indicating 1 as the lowest level of awareness or "strongly disagree" and 10 the highest level of awareness or "strongly agree", depending on what the questions were asked. The Likert scale is a psychometric response scale primarily used in questionaries to obtain participant's preferences or degrees of agreement with a set of statements and it is applied as one of the most fundamental and frequently used tools in social sciences research, as this one is[139] [140]. Finally, the question regarding the knowledge of what regenerative agriculture is was formulated with Yes or No as possible answers.

6.5. Data Analysis

113 variables were formed through the survey. To extract some significant conclusions on the topic approached, the following hypotheses that tried to associate some of the variables were also formulated:

1. Young people are more aware of the drivers of climate change.
2. Young people are more aware of the consequences of climate change.
3. Young people care more about their wellbeing, so they have more responsible habits than the elder.
4. Young people are more likely to change their food habits.
5. People who have more knowledge of the drivers of climate change also know what regenerative agriculture is.

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[138] LIKERT, R., "A technique for the measurement of attitudes", *Archives of Psychology*, Vol. 22, Nº140 (1932), p.5-55, https://legacy.voteview.com/pdf/Likert_1932.pdf

[139] ANKUR, J., SAKET K., SATISH C. & D. K. PAL, "Likert Scale: Explored and Explained", *British Journal of Applied Science and Technology*, 7(4) (2015), p. 396-403, https://www.journalcjast.com/index.php/CJAST/article/view/7498/13368 [accessed 2021-05-20].

[140] BERTRAM, D., "Likert scales… are the meaning of life", p.1-10, http://poincare.matf.bg.ac.rs/~kristina/topic-dane-likert.pdf [accessed 02/05/2021].

6. People that are more aware of regenerative agriculture consume less meat.
7. People that consume meat more frequently present more resistance to reduce or eliminate meat consumption.
8. There is a strong association between eco meat consumption and the level of wealth.

The information of the questionnaire and the 113 variables that resulted from it were analyzed through the open-source IDE (integrated development environment) for R, RStudio, a programming language for statistical computing, and graphs that can be used to code, analyze and graph data.

Within RStudio, descriptive statistics studies were conducted, including frequency analysis, means, medians, modes, standard deviations, quartiles, and others, depending on the type of variable of the sample. If it was qualitative, a frequencies study was performed along with the mode and a graph of its absolute frequency and interpretation. If the variable was quantitative, a summary of its basic descriptive statistics such as the quartiles, mean, standard deviation, maximum and minimum was carried out and interpreted. Histograms were also used to support the numeric information.

To find a statistically significant relationship between two variables, one qualitative and the other quantitative, the nonparametric[141] statistical Kruskal-Wallis[142] test or H was used to assess the differences among independently sampled groups on a single, non-normally distributed continuous variable through the analysis of its means[143]. As none of the variables of the study followed a normal distribution as it was to expect for the kind of questions asked, it was not possible to run the one-way analysis of variance ANOVA[144], which is the parametric test version of Kruskal-Wallis, used for a normally distributed continuous variable. The Kruskal-Wallis test is an extension of the two-group Mann-Whitney U[145] test. Thus, the Kruskal-Wallis is a more generalized form of the Mann-Whitney U test for three or more groups. It is important to remark that in the ANOVA test it is assumed that the dependent variable is normally distributed and there

[141] A "distribution free" test that does not assume your data comes from a particular distribution (STATISTICS HOW TO. (N.d.). *Dunnôs test. Definition.* https://www.statisticshowto.com/dunns-test/ [accessed 2021-05-20]).
[142] KRUSKAL, W. H., & WALLIS, W. A., "Use of ranks in one-criterion variance analysis", *Journal of the American Statistical Association*, Vol. 47, Issue 260, 1952, p. 583–621, https://doi.org/10.2307/2280779
[143] MCKIGHT, P. E., & NAJAB, J. (2010). "Kruskal-Wallis Test", *The Corsini Encyclopedia of Psychology*, https://doi.org/10.1002/9780470479216.corpsy0491
[144] FISHER, R., "The Correlation between Relatives on the Supposition of Mendelian Inheritance.", *Transactions of the Royal Society of Edinburgh*, 52(2),1918, p. 399-433.
[145] MANN, H. B., & WHITNEY, D. R., "On a test of whether one of two random variables is stochastically larger than the other", *Annals of Mathematical Statistics*, Vol. 18, 1947, p. 50–60, https://doi.org/10.1214/aoms/1177730491

are approximately equal variances on the scores across groups. However, when using the Kruskal-Wallis test, these assumptions do not have to be made[146].

To determine if the variables followed a normal distribution, we used the Lilliefors test[147] and for the homogeneity of variances, we used Bartlett's[148] test.

In the Kruskal-Wallis tests, the null hypothesis states that the population medians are all equal, *i.e.*, the groups examined are considered to be from identical populations. Now, to determine whether any of the differences between the means are statistically significant (the significance level is usually denoted as α or alpha), we need to focus on the p-value given by RStudio and its level of significance. If the *p*-value of the variable was smaller than 0.05 (level of significance considered by RStudio which indicates a 5% risk of concluding that a difference exists when there is no actual difference), the differences between some of the means are statistically significant. Thus, we reject the null hypothesis and conclude that not all the group means are equal. On the contrary, if the *p*-value is larger than 0.05, the differences between the medians are not statistically significant, so there is not enough evidence to reject the null hypothesis that the group medians are all equal.

When the p-value is statistically significant, it indicates that at least one of the groups is different from the others, but it does not indicate which groups are different or whether the difference is meaningful, nor does it specify how many of the groups are different from each other. For this, the *post hoc* non-parametric pairwise multiple comparisons test called the Dunn[149] test with Bonferroni[150] adjustments was used. The null hypothesis of the Dunn test is that there is no difference between groups and the alternate hypothesis for the test is that there is a difference between groups[151]. If the *p*-value is smaller than 0.05, then there is a significant difference among the pair of groups analyzed, so we reject the null hypothesis. On the contrary, there will not be a statistically significant difference if the *p*-value is larger than 0.05, so we will not be able to reject

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[146] COMPLETE DISSERTATION BY STATISTICS SOLUTIONS. (N.d.). *Kruskal Wallis Test.* https://www.statisticssolutions.com/kruskal-wallis-test/ [accessed 02/05/2021].

[147] LILLIEFORS, H. W., "On the Kolmogorov-Smirnov test for normality with mean and variance unknown", *Journal of the American Statistical Association*, Vol. 62(318), 1967, p. 399–402. https://doi.org/10.2307/2283970

[148] Introduced in 1937 by Maurice Bartlett (1910–2002).
SNEDECOR, GEORGE W. AND COCHRAN, WILLIAM G., "Statistical Methods", *Iowa State University Press*, Eighth Edition (1989).

[149] DUNN, O. J., "Multiple comparisons among means", *Journal of the American Statistical Association*,56 (1961), p.52–64.
DUNN, O. J., "Multiple comparisons using rank sums", *Technometrics*, 6 (1964), p.241–252.

[150] SIMES, R. J., "An improved Bonferroni procedure for multiple tests of significance", *Biometrika*, 73 (1986), p. 751–754.

[151] STATISTICS HOW TO. *Dunnô s t epinsti on, cit. D*

the null hypothesis. This way, we will be able to identify if and between which groups there is a difference, comparing its means and interpreting in which way they are different.

To study pares of items together, we used the non-parametric Wilcoxon signed-rank[152] test that compares the average of two dependent samples and assesses for significant differences.

Another type of analysis was run for the cases in which both variables were qualitative. The statistical test used for that was a chi-squared[153] test for independence that compares two variables in a contingency table to see if they are related. In a more general sense, it tests to see whether distributions of categorical variables differ from each other and thus, are independent or not. In general, a chi-square statistic is a measure of the difference between the observed and expected frequencies of the outcomes of a set of events or variables. If there is no relationship between the two variables, (that is, if they are independent), then the actual frequencies of the variables should be expected to be approximately equal. Thus, a chi-square test for independence can tell us how likely it is that random chance can explain any observed difference between the actual frequencies in the data and these theoretical expectations[154]. To interpret the results, we first state the null hypothesis that the variables are independent and its alternate hypothesis, *i.e.*, the variables are associated. If the *p*-value given by RStudio is smaller than 0.05, it usually indicates that a difference is significant and so we can reject the null hypothesis and say these two variables are not independent. Opposite to this, if the *p*-value is larger than 0.05 we don't have enough evidence to reject the null hypothesis, so the variables may be independent. To illustrate the results of the chi-squared test, contingency tables were used, summarizing the relationship between both categorical variables, as well as percentage frequency tables.

It is important, before we start the analysis of results, to remark that the question of where people come from was asked as a way to then compare different countries and extract different conclusions. However, as can be appreciated in Table 1, most of the respondents were from Spain, so the results and conclusions extracted from this study were mainly applicable to Spain, as the number of responses of people from other countries was not enough to be generalized. Thus, comparisons between countries were not made in this study.

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[152] WILCOXON, F., "Individual comparisons by ranking methods", *Biometrics Bulletin*, 1 (1945), p. 80–83.
[153] PEARSON, K., "On the criterion that a given system of deviations from the probable in the case of a correlated system of variables is such that it can be reasonably supposed to have arisen from random sampling", *The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science*, 50(302), 1990, p.157–175. https://doi.org/10.1080/14786440009463897
[154] CHI-SQUARE (X2) STATISTIC DEFINITION. (2020). *Investopedia*. https://www.investopedia.com/terms/c/chi-square-statistic.asp

6.6. Results

6.6.1. Hypothesis 1: Young people are more aware of the drivers of climate change.

The results of the descriptive statistics concerning the variable "Knowledge of the drivers of climate change" are represented in table 2:

Table 2. Descriptive statistics analysis of the variable ñKnowledge of the drivers of climate changeò.

N	NA's	Min	Max	1st Qu.	Median	3rd Qu.	RIQ	Mean	SD
323	5	0	10	6	7	8	2	6.89	1.92

N refers to the number of observations of the sample. As we can see, 323 people answered the question "Level of knowledge of the drivers of climate change" which was made on a Likert scale from 1=not much knowledge to 10=a lot of knowledge, and 5 people did not.

The mean or the average most common value in the observations is 6.89, which is above half of the scale, which would be 5. Thus, it seems like people think they are quite aware of what are the drivers of climate change. The standard deviation, in this case, is 1.92, which showed that data was not much widely spread but focused on values close to the mean.

Considering the next question asked in the survey which specified some of the causes as a multiple option answer, the highest percentages were given to GHG emissions (87.80%), human activity (85.67%), excessive generation of waste (84.15%), and polluting non-environmentally friendly transport (80.81%). Nevertheless, the farming industry, which is the most polluting one, was just selected by 53.35% of the people and agriculture only by 37.80%. This leads us to think that even though there is some knowledge about climate change, there is still some awareness to raise among farming and agriculture, which are the main sectors that emit more GHGs and in the end, they are the sectors that affect the food industry the most.

Table 3. ñWhich of these factors do you think are the drivers of climate change?ò

	N	%
	328	100.00%
GHG	288	87.80%
Deforestation	262	79.88%
Natural causes	68	20.73%

Human activity	281	85.67%
Burning of fossil fuels	245	74.70%
Agricultural activities	124	37.80%
Farming / livestock activities	175	53.35%
Volcanic activity	53	16.16%
Polluting non-environmentally friendly transport	263	80.18%
Excessive generation of waste	276	84.15%
Others	9	2.74%

The graphic representation of the variable “Level of knowledge of the drivers of climate change” is the following:

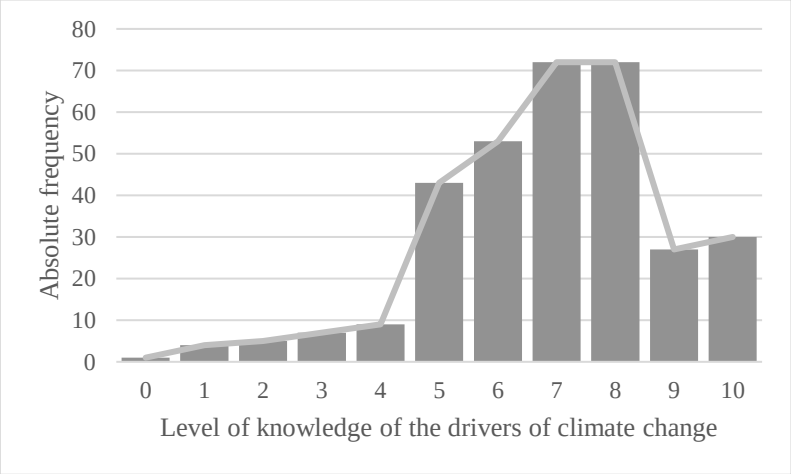


Figure 9. Histogram of the variable "Level of knowledge of the drivers of climate change".

Through this graph, it seems that the mean is between 6 and 8, and the statistical numbers confirm it. It also shows how this variable apparently does not follow a normal distribution, which will be analyzed below with the right statistic tools.

The second variable studied for this hypothesis is “Age”, a qualitative categoric variable that was categorized into 3 groups: “0-30 years old”, “31-60 years old” and “>61 years old”. For this variable, let us analyze first its descriptive statistics.

Table 4. Frequency table of the variable ñAgeò.

Age	Absolute frequency	Relative frequency	Relative percentage frequency	Cumulative Absolute frequency	Cumulative relative frequency
0-30 years old	171	0,526153846	52.62%	171	0.526

31-60 years old	98	0,301538462	30.15%	269	0.828
<61 years old	56 n = 325	0,172307692	17.23%	325	1

Among the 325 observations of the sample, 171 were placed at the young age group that went from “0-30 years old”, 98 in the middle-aged group that went from “31-60 years old”, and 56 in the elder group which went from “61 years old” on. That translates into the following: 52.62% of the respondents were young people, 30.15% were middle-aged people and 17.23% were considered old people. Thus, the mode, which is the value that appears more often was young people (“0-30 years old”). In fact, more than half of the respondents were young people, and the rest belonged to the other two groups. For this reason, we also considered it important to formulate a few hypotheses around the young people group to see significant data and to know if there could really be a change in their food habits, considering that they will be the ones to make the larger impact as they will live longer than the other two groups. The following graph illustrates this same information, as follows:

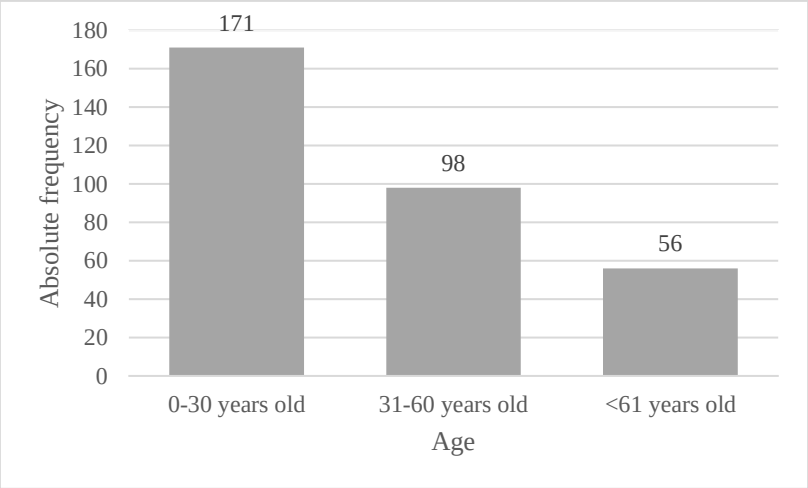


Figure 10. Histogram of the variable "Age".

Observed the basic descriptive statistics of each variable, let us focus on the hypothesis: “young people are more aware of the drivers of climate change”. As one variable is quantitative and numeric, and the other one is qualitative and categoric, the possible statistical test to analyze the hypothesis could be ANOVA. For that, the data need to follow a normal distribution, which is not the case as the Lilliefors test for normality shows a *p*-value $<2.2e^{-16}$ (D=0.14419), which is inferior to 0.05, so we reject the null hypothesis that that data follows a normal distribution. Thus, we use the nonparametric alternative, the Kruskal-Wallis test. To use it, we need to verify the assumption of homogeneity of variances through Bartlett’s test.

Table 5. Bartlettôs test

K-squared	6.6073
df	2
p-value	0.03675

The hull hypothesis is that the variances are equal for all samples. In this case, *p*=0.03675, which means that we could reject the hypothesis and state that there is not homogeneity of variances. Although, seems like there is a tendency to get there as the *p*-value is close to 0.05. Even though we could not guarantee homoscedasticity, we still ran the Kruskal-Wallis test.

Table 6. Kruskal-Wallis H

chi-squared or H	3.6986
df	2
p-value	0.1574

The results of the Kruskal-Wallis chi-squared test were not statistically significant (H = 3.6986, 2 d.f., *p*-value=0.1574<0.05), *i.e.*, the means of individuals within a group are significantly different among the other two groups of age about the knowledge of the drivers of climate change, so there is no significant difference between their responses of the questionnaire. Thus, we concluded that the knowledge of these drivers does depend on the age level of the participants.

6.6.2. Hypothesis 2: Young people are more aware of the consequences of climate change.

Descriptive statistics for the variable "Age" were just done in hypothesis 1 and summarized in table 4. For the quantitative numeric variable "Awareness of the consequences of climate change", the basic descriptive statistics are summarized in table 7, as follows:

Table 7. Descriptive statistics analysis of the variable ñawareness of the consequences of climate changeò.

N	NA's	Min	Max	1st Qu.	Median	3rd Qu.	RIQ	Mean	SD
320	8	0	10	6	7	8	2	6.86	1.87

There were 320 observations of the sample, which means 323 people answered the question "Are you aware of the consequences of climate change?", formulated through a Likert scale that went from 1=low awareness to 10=high awareness. As NA's, 8 people did not answer.

The mean or the average most common value in the observations is 6.86, above half of the scale, which would be 5. The results showed that most participants believe that they are aware of the consequences of climate change. The standard deviation is 1.87, which shows that data is not much widely spread but focuses on values close to the mean.

Comparing this mean to the mean of the variable "level of knowledge of the drivers of climate change", which was 8.89, it seems like participants have the same knowledge about both causes and consequences of climate change, as the mean values are almost equal.

Considering the next question asked in the survey which specified some of the consequences of climate change as a multiple option answer, the highest percentages were given to the rise in global temperature (95.43%), meltdown (86.28%), sea levels rise (83.23%), alterations in rain cycles and more floods (82.01%) and degradation of ecosystems (81.40%). However, it is important to remark that the anticipation of spring is a clear sign of climate change and seems a bit alarming that less than half of the population (43.90%) knew it.

Table 8. "**Do you know what the consequences of climate change are?ò** [g]

	N	%
	328	100.00%
Anticipation of spring	144	43.90%
Rise in global temperature	313	95.43%
Meltdown	283	86.28%
Alterations in rain cycles and more floods	269	82.01%
Sea levels rise	273	83.23%
More episodes of El Niño	120	36.59%
Increase in droughts	246	75.00%
Degradation of ecosystems	267	81.40%
Outbreaks of swine fever	42	12.80%
Increase in infectious diseases	117	35.67%
Others	4	1.22%

Going back to our variable of interest, "Awareness of the consequences of climate change", its absolute frequency is summarized in the following histogram:

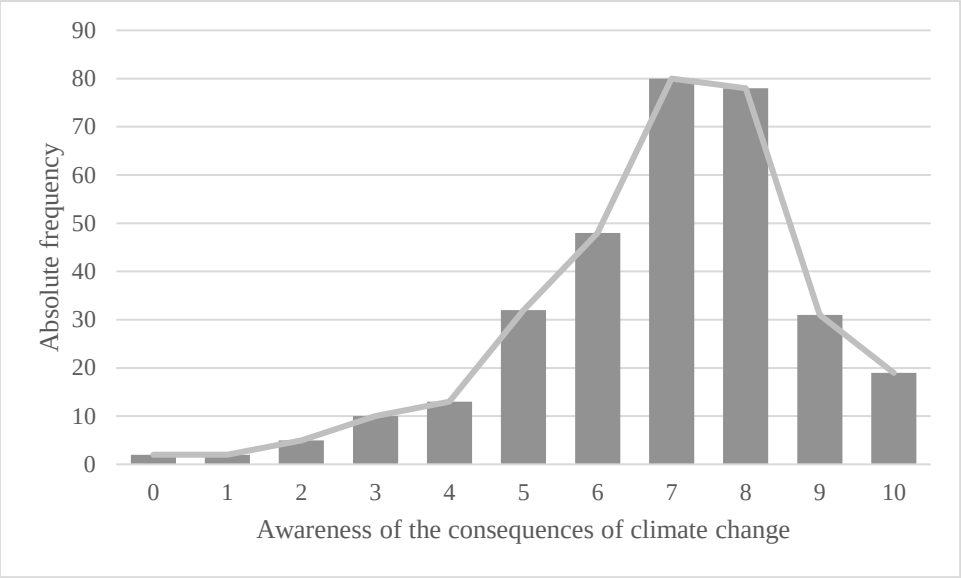


Figure 11. Histogram of the variable "Awareness of the consequences of climate change".

Hypothesis number 2 was: “young people are more aware of the consequences of climate change”. One variable is quantitative and numeric, and the other one is qualitative and categoric.

We ran the Lilliefors test for normality and it showed a *p*-value $<2.2e^{-16}$ (D=0.17998), which is inferior to 0.05, so we rejected the null hypothesis that that data follows a normal distribution.

The assumption of homogeneity of variances through Bartlett’s test was analyzed, resulting in the following:

Table 9. Bartlettô s t e s t

K-squared	3.4616
df	2
p-value	0.1771

Through this test, we could not reject the null hypothesis of homogeneity of variances as p=0.1771>0.05. Thus, we could confirm the assumption of homogeneity and proceed with the non-parametric Kruskal-Wallis test to see if there were significant differences between the means of the groups of “Age” concerning the awareness of the consequences of climate change.

Table 10. Kruskal-Wallis H test

chi-squared or H	2.4774
df	2
p-value	0.2898

The results of the Kruskal-Wallis chi-squared test were not statistically significant (H = 2.4774, 2 d.f., *p*-value=0.2898>0.05), *i.e.*, the means of individuals within a group are not significantly

different among the other two groups of age regarding the knowledge of the consequences of climate change, so there is no significant difference between their responses of the questionnaire. Consequently, we could not state that a specific group of age is more aware or less aware of the consequences of climate change with the other two groups as this awareness is not statistically related to the age of the participants.

6.6.3. Hypothesis 3: Young people care more about their wellbeing, so they have more responsible habits than the elder.

Again, the variable "Age" has already been analyzed in hypothesis 1.

To define which are the health habits of the population, we created a new variable called "General health care" as the sum of the items "I mind my health" and "I take care of my nutrition". As both variables are numerical and quantitative and were formulated through a Likert scale going from 1=not much care to 10=a lot of care, when adding one variable to the other, the scale turned into 1=not much care to 20=a lot of care.

The descriptive statistics of this new variable are the following:

Table 11. Descriptive statistics analysis of the variable General health care.

N	NA's	Min	Max	1st Qu.	Median	3rd Qu.	RIQ	Mean	SD
326	2	1	20	14	16	18	4	15.73	3.07

N=326, *i.e*, 326 people answered the questions of health care and 2 people did not. The mean is 15.73, above half of the Likert scale, which would be 10, and the results showed that most participants care about their health as the mean is closer to 20 than to 1. The standard deviation is 3.07, which shows that data is not much widely spread.

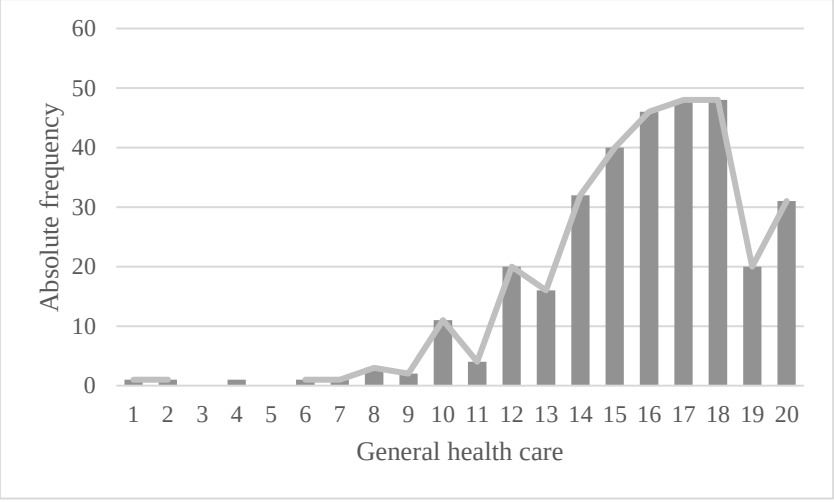


Figure 12. Histogram of the variable "General health care".

The graph illustrates that most of the values are centered around 14,15,16,17 and 18, which makes sense with a mean of 15.73. However, we can already appreciate that the variable does not follow a normal distribution.

Now, considering the hypothesis "Young people have more responsible habits than elder people", the normality Lilliefors test gave a *p*-value $<7.749e^{-14}$ (D=0.1271), which is inferior to 0.05, so we rejected the null hypothesis that that data follows a normal distribution.

To verify the assumption of homogeneity of variances, we used Bartlett's test for non-normal distributions, which showed a *p=0.3761*> 0.05, thus the variances were equal.

Table 12. Bartlettô s t e s t

K-squared	1.9556
df	2
p-value	0.3761

Then we proceeded with the Kruskal-Wallis test, which results are summarized in the table below:

Table 13. Kruskal-Wallis H test

chi-squared or H	3.6008
df	2
p-value	0.1652

As the *p*-value (=0.1652) is larger than 0.05, we concluded that there is not statistical significance, so we could not reject the null hypothesis that stated that the means of individuals within a group are not significantly different among the other two groups of age regarding their general health care. In other words, the level of health care that the participants showed is not related to their age.

6.6.4. Hypothesis 4: Young people are more likely to change their food habits.

The descriptive statistics of the variable "Age" were already analyzed in hypothesis 1.

Now, to analyze the food habits of the participants, we took all the items[155] of the question "I would be willing to change my food habits, if…" and we converted them into one single variable that would include them all, called "Food habits". Now, the Likert scale of all the items that went

[155] You can see them in detail in Annex 1.

from 1 to 10 was converted on a larger scale, going from 1= I would not be willing to change to 50=I would be willing to change. Its descriptive statistics are the following:

Table 14. Descriptive statistics analysis of the variable Food habits

N	NA's	Min	Max	1st Qu.	Median	3rd Qu.	RIQ	Mean	SD
321	7	1	50	25	31	36	11	30.66	9.11

N=321, *i.e.*, 321 people answered all the questions englobed in Food habits, and 7 people did not. The mean is 30.66, a bit above the half of the Likert scale, which would be 25 in this case, and the results showed that most participants would maybe change some of their food habits in benefit of the planet, considering all the conditioning aspects such as a higher price and a better quality, among others. The standard deviation is 9.11, which showed that data is not much widely spread.

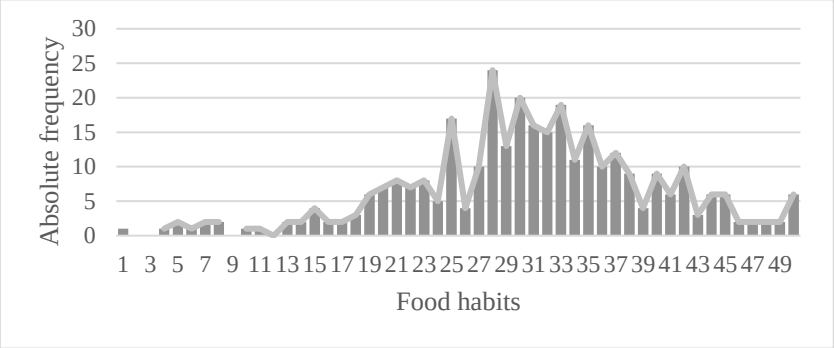


Figure 13. Histogram of the variable "Food habits".

With this histogram, it is clear again where the mean would be, as the most common values are around 25-35, and it is also obvious that the variable of study does not follow a normal distribution, even though it is a bit more normally distributed than the variables studied before, as now there is more information about the aspects of health as 5 variables turned into 1 (there are more observations for this variable).

Going back to the hypothesis “young people are more likely to change their food habits”, we ran the normality Lilliefors test, which showed a *p*-value =4.037e^{-5} (D=0.079827), which is inferior to 0.05, so one more time we rejected the null hypothesis that that data follows a normal distribution.

Table 15. Bartlettô s t e s t

K-squared	19.255
df	2
p-value	6.59e^{-5}

Through Bartlett's test, we rejected that the variances were equal as $p=6.59e^{-5}<0.05$, but even if we could not guarantee the assumption of homoscedasticity, we ran the Kruskal-Wallis test.

Table 16. Kruskal-Wallis H test

chi-squared or H	9.7621
df	2
p-value	0.007589

The results of the Kruskal-Wallis chi-squared test were statistically significant (H = 9.7621, 2 d.f., *p*-value=0.007589<0.05), *i.e.*, the means of individuals within a group are significantly different among the other two groups of age regarding the willingness to change the food habits. Thus, there may be a relationship between these two variables. So, to know which group differed from which other one, we ran the Dunn test with the *p*-values adjusted with the Bonferroni method, and the results showed as follows:

Table 17. Dunn test results

Comparison	Z	p.unadj	p.adj
<61 years old, 0-30 years old	-3.10174	0.0019238	0.005772
<61 years old, 31-60 years old	-2.41334	0.015807	0.0474211
0-30 years old, 31-60 years old	0.5559797	0.5782247	1

Pairwise comparisons using Dunn's test indicated that group "<61 years old" scores were observed to be significantly different from those of group "31-60 years old" and group "0-30 years old" too. Between "<61 years old" and "0-30 years old" groups there is a potential statistical significance tendency, as *p.adj*=0.005772, just as 0.05 alpha value. Thus, we concluded that the young group (M= 31,3824) is more open to change their food habits than the elder group (M= 27,8364).

Between "<61 years old" and "0-30 years old", there is also statistical significance as *p.adj*=0,0474211, which is inferior to 0.05, where the middle-aged group is more likely to change the food habits (M=31) than the elder group (M= 27,8364).

Regarding the "0-30 years old" group and "31-60 years old" group, there is no sufficient statistical significance to say that these two groups differ one from the other and that one is more likely to change the food habits in comparison to the other.

A sub hypothesis was made to know which one of the factors is more relevant when considering changing the food habits. For that, we calculated the mean of each food habits item that made up this scale and then applied the Wilcoxon test to compare the averages of two of the 5 dependent

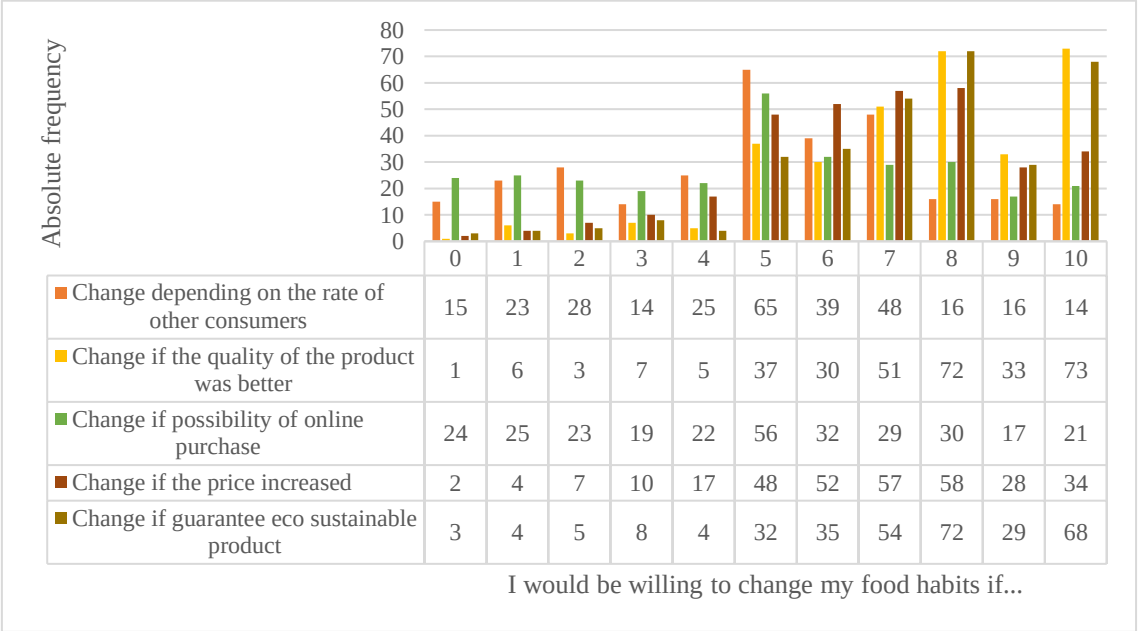
samples analyzed to see if there were significant differences, starting to compare the two items that had the higher mean.

The table below organizes the mean from higher to lower, as follows, considering that the variables were formulated using a Likert scale going from 1=low willingness to change to 1=high willingness to change.

Table 18. Means of the 5 items.

	If the quality of the product was better	If there is a guarantee of eco-sustainable product	If the price increases	Depending on the rating of other consumers	If there is a possibility of an online purchase
Mean (M)	7,477987	7,38535	6,69716	5,042904	5,013423

The highest mean corresponds to the item “If the quality of the product was better”, followed by “If there is a guarantee of eco-sustainable product”, “If the price increases”, “Depending on the rating of other consumers” and finally “If there is a possibility of an online purchase” presented the lowest mean.



	0	1	2	3	4	5	6	7	8	9	10
Change depending on the rate of other consumers	15	23	28	14	25	65	39	48	16	16	14
Change if the quality of the product was better	1	6	3	7	5	37	30	51	72	33	73
Change if possibility of online purchase	24	25	23	19	22	56	32	29	30	17	21
Change if the price increased	2	4	7	10	17	48	52	57	58	28	34
Change if guarantee eco sustainable product	3	4	5	8	4	32	35	54	72	29	68

Figure 14. Histogram of the 5 items together.

In order to know which item affects the will to change the food habits the most, we ran the Wilcoxon signed-rank test firstly between the highest and second-highest mean. The results are the following:

Table 19. Wilcoxon signed-rank test between variables "change product was bought if there is a sustainable product" and "change if there is a sustainable product"

W	10836
p-value	0.1704

The results of the Wilcoxon signed-rank test showed that there is no statistically significant difference between these two first groups as p=0.1704>0.05, so we could not state that one induces more consumers to change their habits than the other.

For this reason, we compared the second highest mean with the third-highest mean, and the first highest mean with the third one.

Table 20. Wilcoxon signed-rank test between variables "change if that it is an eco-sustainable product" and "change if the"

V	15859
p-value	$6.082e^{-09}$

Table 21. Wilcoxon signed-rank test between "change if the quality of the product was better" and "change if the price"

V	14727
p-value	$2.98e^{-12}$

Both tables show that there is a statistically significant difference between the two groups that have the first and second highest mean, as they showed *p*-values inferior to 0.05, compared to the group that has the third-highest mean. Thus, we could remark that it is likely that the two most influential factors are the better quality of the product and the guarantee of an eco-sustainable product.

6.6.5. Hypothesis 5: there is a relationship between the knowledge of the drivers of climate change and regenerative agriculture.

The descriptive statistics of the variable "level of knowledge of the drivers of climate change" have already been analyzed and summarized in hypothesis 1.

Regarding the variable "Do you know what regenerative agriculture is", it is a binary categoric variable, with its basic characteristics summarized in the table below:

Table 22. F r e q u e n c y t a b l e o f t h e v a r i a b l e ñ D i s ? ò

Do you know what regenerative agriculture is?	Absolute frequency	Relative frequency	Relative frequency percentage	Cumulative Absolute frequency	Cumulative relative frequency
Yes	96	0.30	29.72%	96	0.30
No	227	0.70	70.30%	323	1
	n=323				

Firstly, 323 participants responded to this question, 96 of which responded to know what regenerative agriculture is, and another 227 answered they did not. That translates into 70% of the sample do not know what regenerative agriculture is, which means that they also do not know it can be an effective solution to climate change. The other 30% stated that they know what regenerative agriculture is, which probably means that they know its benefits for the planet and its impact on CO_2 accumulated in the air. The mode of this variable, thus, is "No".

The next histogram illustrates the absolute frequency of this variable, as follows:

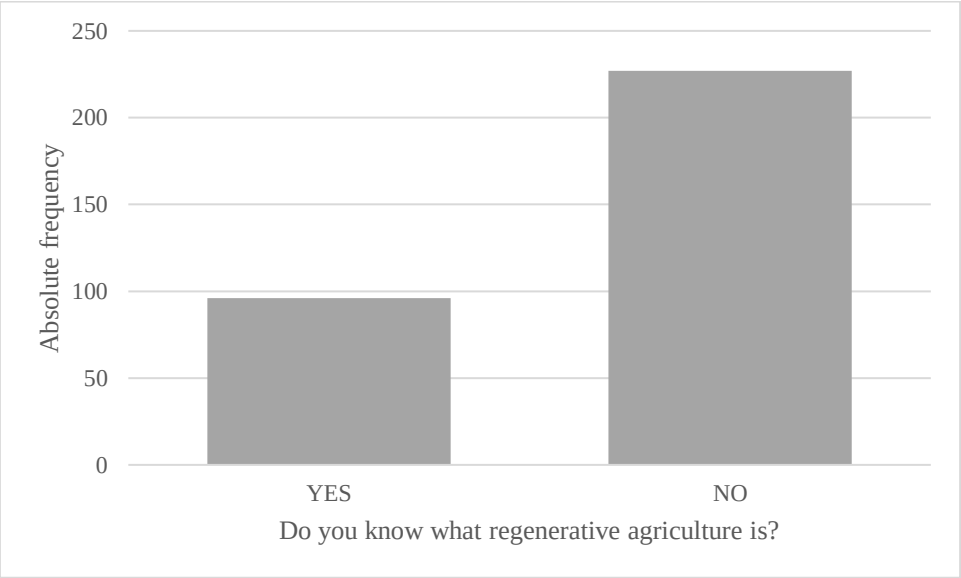


Figure 15. Histogram of the variable "Do you know what regenerative agriculture is?".

Going back to the hypothesis "there is a relationship between the knowledge of the drivers of climate change and regenerative agriculture", the normality Lilliefors test showed a *p*-value $<2.2e^{-16}$ (D=0.14419), so we rejected the null hypothesis that data follows a normal distribution.

Table 23. Bartlettô s t e s t

K-squared	1.9335
df	1
p-value	0.1644

Through Bartlett's test, the homogeneity of variances was confirmed as p=0.1644>0.05.

As the variable "do you know what regenerative agriculture is" has two groups, we ran the Mann-Whitney U test or also known as Wilcoxon rank-sum test.

Table 24. Mann-Whitney U test

W	102339
p-value	$< 2.2e^{-16}$

The results of the Mann-Whitney U test were statistically significant (W = 102339, p-value$< 2.2e^{-16}<0.05$), *i.e.*, the means of individuals within a group are significantly different among the other group. Thus, we could reject the null hypothesis and conclude that there is a relationship between people who are more aware of the drivers of climate change and their knowledge of regenerative agriculture.

Then, we used the Dunn test to see which categories were significantly different from each other and in which way they differed.

Table 25. Dunn test results

Comparison	Z	p.unadj	p.adj
No-Yes	-3.066718	0.002164231	0.002164231

As we can observe in table 16, $p.adj$=0.002164231, which is inferior to 0.05. Thus, it appeared to be statistically significant. People who know what regenerative agriculture is, have more knowledge of the drivers of climate change (M=7.35) than those who do not know what regenerative agriculture is (M=6.68). This is probably because they are also aware that agricultural activities have an impact on climate, and they probably chose it also as a driver of climate change. To be sure, we ran a quick chi-squared test that gave a p=0.102 (X^2=2.6734, 1 df). This value is in the limit of the significance of 10%, for we concluded that if the sample would have been sufficiently big enough, the p-value would have also been significant.

6.6.6. Hypothesis 6: there is a relationship between the awareness of regenerative agriculture and meat consumption.

Descriptive statistics of the variable “Do you know what regenerative agriculture is?” were already analyzed and exposed in hypothesis 5.

The variable “how often do you eat meat” is a categoric qualitative variable, with the following frequencies:

Table 26. Frequency table of the variable ñHow o

How often do you eat meat?	Absolute frequency	Relative frequency	Relative percentage frequency	Cumulative Absolute frequency	Cumulative relative frequency
Once a week	42	0.1284	12.84%	42	0.128
2-3 times a week	179	0.5474	54.74%	221	0.676
Every day of the week	42	0.1284	12.84%	263	0.804
2-3 times a month	13	0.0398	3.98%	276	0.844
Rarely	18	0.055	5.50%	294	0.899
I do not eat meat	33	0.1019	10.09%	327	1.000
	n=327				

The table shows that 327 participants responded to this question and that more than half (54.74%) of them consume meat 2-3 times a week (mode). Only 10% clearly stated that they do not eat meat, 4% that eat 2-4 times a month, 5.50% rarely eat meat and 12.84% that both eat meat once a week or even every day of the week. So, the general tendency is that meat is still present in every week meals.

The following histogram represents it.

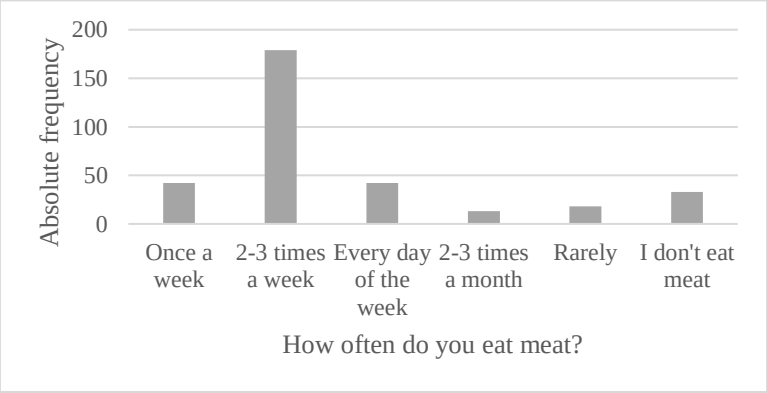


Figure 16. Histogram of the variable "how often do you eat meat?".

Focusing on the hypothesis now, which is that there is a relationship between the awareness of regenerative agriculture and meat consumption, as both variables are qualitative, we ran a chi-squared test and extracted the following values:

Table 27. Chi-squared test.

X-squared	12.135
df	5
p-value	0.03299

As p=0.03299<than 0.05, we rejected the null hypothesis and affirmed that there is no independence between variables, so there is a significant statistical relationship between how often people consume meat and the awareness of what regenerative agriculture is. In order to see which kind of association there is between the variables, we analyzed the contingency and percentage tables.

Table 28. Contingency table of ñHow often regenerative.agriculture i

	Do you know what regenerative agriculture is?		
How often do you eat meat?	Yes	No	Totals
Once a week	18	22	40
2-3 times a week	48	130	178
Every day of the week	6	35	41
2-3 times a month	5	8	13
Rarely	8	10	18
I don't eat meat	11	22	33
Totals	96	227	323

Table 29. Total percentages table of ñHow often do you regenerative.agriculture is

	Do you know what regenerative agriculture is?		
How often do you eat meat?	Yes	No	Totals
Once a week	0,0557	0,0681	0.1238
	(5.57%)	(6.81%)	(12.38%)
2-3 times a week	0.1486	0.4025	0.5511
	(14.86%)	(40.25%)	(55.11%)

Every day of the week	0.0186	0.1084	0.1269
	(1.86%)	(10.84%)	(12.69%)
2-3 times a month	0.0155	0.0248	0.0402
	(1.55%)	(2.48%)	(4.02%)
Rarely	0.0248	0.0310	0.0557
	(2.48%)	(3.10%)	(5.57%)
I do not eat meat	0.0341	0.0681	0.1022
	(3.41%)	(6.81%)	(10.22%)
Totals	0.2972	0.7028	1
	(29.72%)	(70.28%)	(100%)

From these two tables, we extracted the following conclusions: from the total of participants, most of them (70.28%) do not know what regenerative agriculture is. Also, irrespective of the knowledge of regenerative agriculture, the bigger scores went to the consumption of meat 2-3 times a week. From the total, 14% said they know what regenerative agriculture is and eat meat 2-3 times a week, and 40.25% of the people do not know what regenerative agriculture is and eat meat 2-3 times a week.

Table 30. Column percentages table of ñHow often do you regenerative.agriculture is

	Do you know what regenerative agriculture is?	
How often do you eat meat?	Yes	No
Once a week	0.1875	0.0969
	(18.75%)	(9.69%)
2-3 times a week	0.5000	0.5727
	(50.00%)	(57.27%)
Every day of the week	0.0625	0.1542
	(6.25%)	(15.42%)
2-3 times a month	0.0521	0.0352
	(5.21%)	(3.52%)
Rarely	0.0833	0.0441
	(8.33%)	(4.41%)
I don't eat meat	0.1146	0.0969
	(11.46%)	(9.69%)
Totals	1	1
	(100%)	(100%)

If we consider the column percentages, from the people who know what regenerative agriculture is, the highest percentage went to those who eat meat 2-3 times a week (50%). The next bigger percentage were those who eat meat just once a week (18.75%). Only 6.25% eat meat every day. From these statements, we concluded that the fact that the population knows what regenerative agriculture does not mean they stop eating meat, yet they eat more responsibly, so at least not every day of the week.

From the people who did not know what regenerative agriculture is, 57.27% of them eat meat 2-3 times a week, 15.42% eat it every day of the week and 9.69% eat it once a week. It seems like the level of consumption was higher and shortened in time in comparison with those who know what regenerative agriculture is, which were not many in the percentage of the total population. It is also remarkable that for the options "I don't eat meat", "I rarely eat meat", "I eat meat 2-3 times a month" or "I eat meat once a week", the percentages were higher for those who know what regenerative agriculture is, while these percentages decreased and focused more on "2-3 times a week" or even "every day of the week" for the people who do not know what regenerative agriculture is. In fact, the difference was highly significant regarding everyday meat consumption, as there is a difference of almost 10% between the groups. Also, for those who said they eat meat just once a week, the percentages were quite far from each other in the sense that people that know what regenerative agriculture is responded to eat more meat just once a week than the people who do not know it, who responded to eat more meat every day.

Thus, it seems to be correct to suggest that the participants who responded they know what regenerative agriculture is, may be more responsible when it comes to how often they eat meat.

6.6.7. Hypothesis 7: People that consume meat more frequently present more resistance to reduce or eliminate meat consumption.

To simplify the study, we recoded the variable "How often do you eat meat" into 3 groups: "frequently", "rarely" and "never". The new frequency table is the following:

Table 31. F r e q u e n c y t a b l e o f t h e n e w v a r i a

How often do you eat meat?	Absolute frequency	Relative frequency	Relative percentage frequency	Cumulative Absolute frequency	Cumulative relative frequency
Frequently	263	0.804	80.43%	263	0,804
Rarely	31	0.095	9.48%	294	0,899
Never	33	0.101	10.09%	327	1
Totals	327	1	100.00%		

From the 327 responses, 263 participants stated that they eat meat frequently, 31 stated that they rarely eat meat, and 33 stated that they never eat meat. It is clear then that the mode is “frequently”, as 80.43% of the sample stated to eat meat frequently.

The graphical representation of the absolute frequency of this variable is the following:

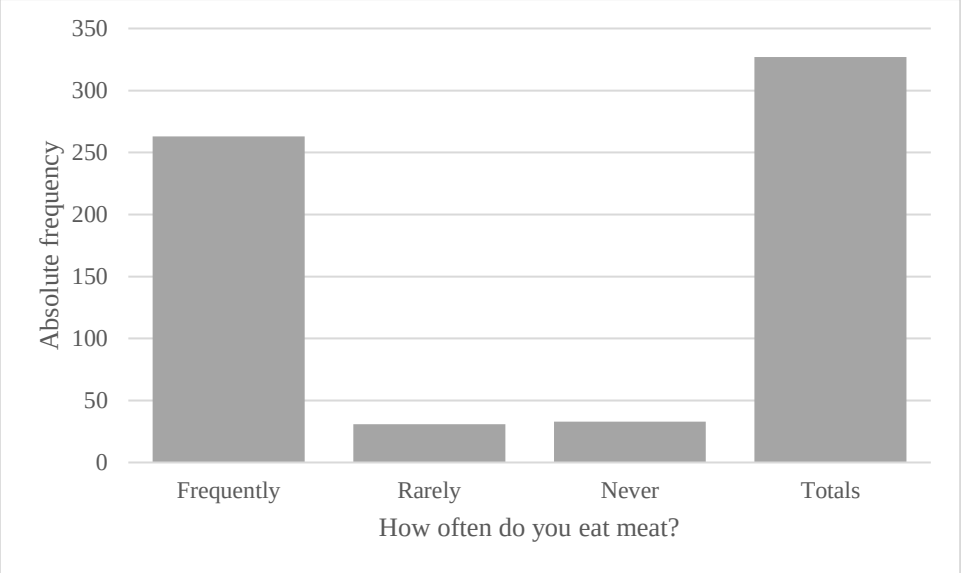


Figure 17. Histogram of the new variable "how often do you eat meat?"

The variable “mass meat production” considered mass production of meat as one of the largest contributors to greenhouse gas emissions. Its question in the survey asked the participants if they would be willing to reduce meat consumption, stop it or not change it at all.

The descriptive statistics of this variable are:

Table 32. Mass meat production distribution of frequencies.

Mass meat production	Absolute frequency	Relative frequency	Relative percentage frequency	Cumulative Absolute frequency	Cumulative relative frequency
Reduce	214	0.663	66.25%	214	0.663
Stop	66	0.204	20.43%	280	0.867
Not change	43	0.133	13.31%	323	1
Total	323	1.000	100%		

From a total of 323 people that answered the question, 214 of them (or 66.25%) responded that they would be willing to reduce their meat consumption for the benefit of the planet, 66 people (or 20.43%) stated they would stop eating meat, and 43 people (13.31%) said they would not

change their meat consumption despite the negative impact that this would mean to climate change and the planet in general.

The graph illustrates it as follows:

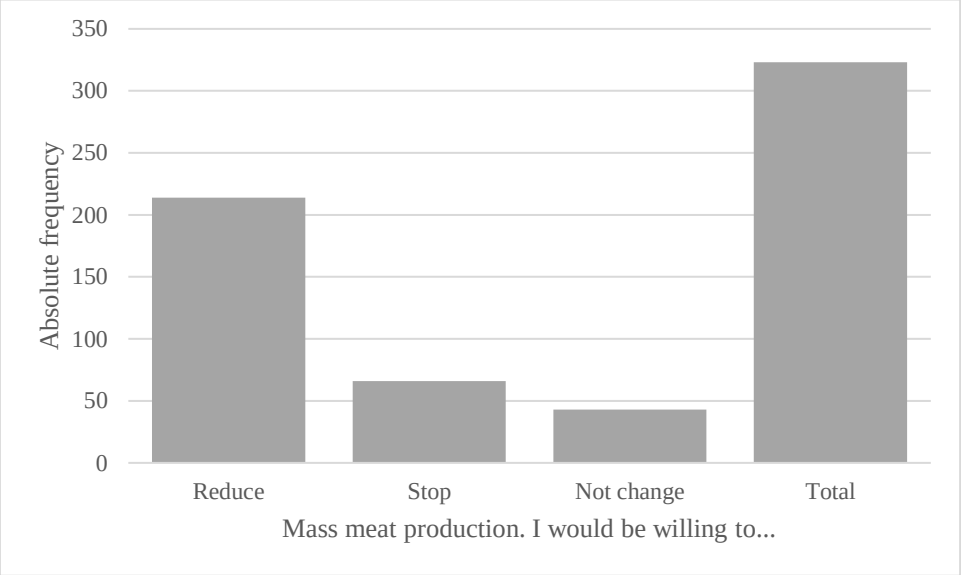


Figure 18. Histogram of the variable "mass meat production".

Going back to the hypothesis “people that consume meat more frequently present much resistance to reduce or eliminate meat consumption”, a chi-squared test was made to evaluate the relationship between these two variables.

Table 33. Chi-squared test

X-squared	179.95
df	4
p-value	$<2.2e^{-16}$

$P=<2.2e^{-16}<0.05$, thus we rejected the null hypothesis and affirmed that there is no independence between variables, so there is a significant statistical relationship between how often people consume meat and their willingness to change their meat consumption. In order to see in which direction this association goes, contingency and percentage tables were analyzed.

Table 34. Contingency table of ñmass meat productionò and the new variable of ñhow often do you eat meat?ò .

	New “how often do you eat meat?”			
Mass meat production	Frequently	Rarely	Never	Totals
Reduce	203	11	0	214

Stop	17	17	32	66
Not change	41	2	0	43
Totals	261	30	32	323

Table 35. Total percentages table of ñmass meat productionò and the new variable of ñhow often do you eat meat?ò .

	New "how often do you eat meat?"			
Mass meat production	Frequently	Rarely	Never	Totals
Reduce	0.6285 (62.85%)	0.0341 (3.41%)	0.0000 (0%)	0.6625 (66.25%)
Stop	0.0526 (5.26%)	0.0526 (5.26%)	0.0991 (9.91%)	0.2043 (20.43%)
Not change	0.1269 (12.69%)	0.0062 (0.62%)	0.0000 (0%)	0.1331 (13.31%)
Totals	0.8080 (80,80%)	0.0929 (9,29%)	0.0991 (9,91%)	1 (100%)

From these first two tables it can be observed that from the total of participants, most of them responded to eat meat frequently (80,80%) and a minority responded to either rarely eat meat (9.29%) or just not eat meat (9.91%). However, 66.25% were also willing to reduce their consumption, which would likely benefit the planet and pollution would be reduced.

In terms of the total population, it is remarkable that 203 of the participants (62.85 %) who said to eat meat frequently would be willing to reduce their meat consumption, while a 5.26 % that also stated to eat meat frequently would stop and a 12.69% would not change their consumption habits.

Table 36. Row percentages table of ñmass meat productionò and the new variable of ñhow often do you eat meat?ò .

	Grouped meat consumption			
Mass meat production	Frequently	Rarely	Never	Totals
Reduce	0.9486 (94.86%)	0.0514 (5.14%)	0 (0%)	1 (100%)
Stop	0.2576 (25.76%)	0.2576 (25.76%)	0.4848 (48.48%)	1 (100%)

Not change	0.9535 (95.35%)	0.0465 (4.65%)	0 (0%)	1 (100%)

If we focus on the rows, it can be appreciated that among the people who would be willing to reduce their meat consumption, almost 95% responded to eat meat frequently and the rest to rarely eat it. The ones who responded to never eat meat would not reduce it, so there are no answers to this gap.

Among the people who would stop eating meat, 25.75% said they eat meat frequently and the same percentage said rarely. Also, 48.48% of people who said they would stop eating meat, already do not eat it, so it may be a form of reaffirmation on what society should do to take care of the planet.

From the people that stated they would not change their meat consumption, 95.35% appeared to eat meat frequently and the rest (4.65%) to rarely eat it. So, in this case, we can observe that most resistance to not change meat consumption comes from the people who eat meat frequently, although, in terms of total proportions, most people who eat meat would be willing to reduce their consumption.

Table 37. Column percentages table of ñmass meat productionò and the new variable of ñhow often do you eat meat?ò .

	New meat consumption		
Mass meat production	Frequently	Rarely	Never
Reduce	0.7778 (77.78%)	0.3667 (36.67%)	0 (0%)
Stop	0.0651 (6.51%)	0.5667 (56.67%)	1 (100%)
Not change	0.1571 (15.71%)	0.0667 (6.67%)	0 (0%)
Totals	1 (100%)	1 (100%)	1 (100%)

Focusing on column percentages, among the people who said to eat meat frequently, 77.78% would be willing to reduce their consumption, 6.51% would stop it, and 15.71% would not change it.

Among the people who stated they rarely eat meat, 36.67% said they would be willing to reduce their meat consumption, more than half (56.67%) would directly stop eating meat, and 6.67% would not change their consumption.

Finally, the people who said they never eat meat, all responded to this question that they would stop eating meat.

As a sub hypothesis of hypothesis 7, we wanted to analyze if people that are more aware of the current climate situation would present lower resistance to change their meat consumption than those who are not.

The variable mass meat consumption has already been studied above. The summary of the variable "awareness of the situation", formulated as a Likert scale that goes from 1=not much to 10=high awareness, is the following:

Table 38. Descriptive statistics of the

N	NA's	Min	Max	1st Qu.	Median	3rd Qu.	RIQ	Mean	SD
323	5	1	10	5	7	8	3	6.659	1.993

From table 38, we extracted the following information: 323 participants responded to the question while 5 didn't. The mean is 6.659, which means that the average level of awareness of the population is below 5, which we could interpret as higher than lower. It is almost a 7 on a 1-10 scale, so it shows that to their average opinion, they have a high level of awareness.

Focusing on the sub hypothesis now, which is that people who are more aware of the current climate situation present lower resistance to change their meat consumption than those who are not, we ran the normality Lilliefors test, which showed a p-value =$6.409e^{-16}$ (D=0.13645), which is inferior to 0.05, so we rejected the null hypothesis that data follows a normal distribution.

Bartlett's test showed a p=0.0057<0.05, so we could not confirm the assumption of homoscedasticity.

Table 39. Bartlettô s .t e s t

K-squared	10.335
df	2
p-value	0.0057

Then, we ran the Kruskal-Wallis test and summarized the results:

Table 40. Kruskal-Wallis H test.

chi-squared or H	1.0173
df	2
p-value	0.6013

The results of the test were not statistically significant (H = 1.0173, 2 d.f., *p*-value=0.6013>0.05), so we did not have enough evidence to reject the null hypothesis and thus concluded that there is not a relationship statistically significant enough between the level of awareness of the current climate situation and the resistance to reduce meat consumption.

6.6.8. Hypothesis 8: there is a strong association between organic/ecological meat consumption and the level of wealth.

The variable "organic/conventional meat" comes from the question that considers organic/ecological meat, due to differences in its treatment, healthier than regular/conventional meat, and asks if participants would be willing to change their habits and thus consume organic meat or just keep consuming regular meat. The basic characteristics of this variable are the following:

Table 41. Frequency table of the variable ñ o

Organic/ conventional meat consumption	Absolute frequency	Relative frequency	Relative percentage frequency	Cumulative Absolute frequency	Cumulative relative frequency
Organic meat	272	0.906667	90.67%	272	0.906667
Conventional meat	28	0.093333	9.33%	300	1
Totals	300	1	100.00%		

People that did not eat meat were excluded from these questions, as well as the ones who did not answer. Among the 300 participants considered in this question, 90.67% said they would consume organic meat, while just 9.33% stated that would keep on eating regular meat.

The graph below shows this big difference between both possible answers:

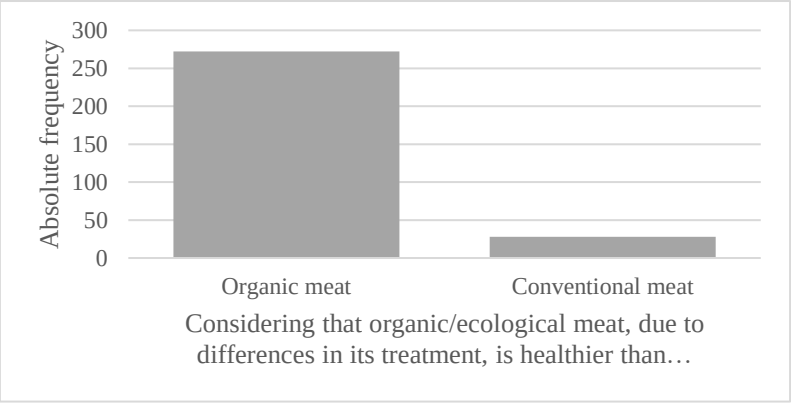


Figure 19. Histogram of the variable "Considering that organic/ecological meat, due to differences in its treatment, is healthier than regular/conventional meat, I would be willing to consume...ò

The descriptive statistics for the variable “monthly net wage” are the following:

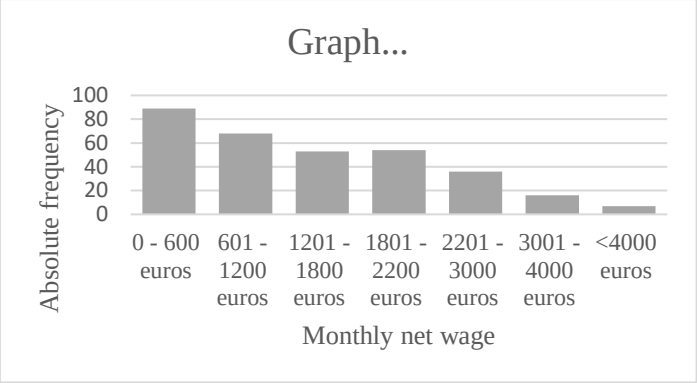
Table 42. F r e q u e n c y t a b l e o f t h e v a r i a l

Monthly net wage	Absolute frequency	Relative frequency	Relative percentage frequency	Cumulative Absolute frequency	Cumulative relative frequency
0 - 600 euros / 0 - 728 dollars / 0 - 10519 Rands	89	0.276	27.55%	89	0.276
601 - 1200 euros / 729 - 1456 dollars / 10520 - 21038 Rands	68	0.211	21.05%	157	0.486
1201 - 1800 euros / 1457 dollars - 2184 dollars / 21039 - 31558 Rands	53	0.164	16.41%	210	0.650
1801 - 2200 euros / 2185 - 2670 dollars / 31559 - 38571 Rands	54	0.167	16.72%	264	0.817
2201 - 3000 euros / 2671 - 3640 dollars / 38572 - 52597 Rands	36	0.111	11.15%	300	0.929
3001 - 4000 euros / 3641 - 4854 dollars / 52598 - 70129 Rands	16	0.050	4.95%	316	0.978

+ 4000 euros / + 4855 dollars / + 70130 Rands	7	0.022	2.17%	323	1
Totals	323	1	100%		

From the absolute frequencies table, we can observe that the number of participants in each group decreases as the wage increases. Translating it into percentages, 27.55% of the participants reported a monthly net wage of 0 - 600 euros, 21.05% reported a monthly net wage of 601 - 1200 euros, 16.41% presented a monthly net wage of 1201 - 1800 euros, 11,15% reported a monthly net wage of 2201 - 3000 euros, 4.95% presented a monthly net wage of 3001 - 4000 euros and only 2.17% of the respondents reported a monthly net wage of more than 4000 euros.

This decreasing tendency is shown in the following histogram:



Returning to the hypothesis that there is a strong association between the organic/ecological meat consumption and the level of wealth, the chi-squared test gave the following results:

Table 43. Chi-squared test

X-squared	4.3557
df	6
p-value	0.6287

As p=0.6287>0.05, these two studied variables appeared to be independent. Thus, there is no clear and significant statistical association between wage and meat consumption[156].

[156] For more detailed information, you can visualize the contingency table as well as the percentages table in Annex 2.

As a sub hypothesis, we decided to analyze if people that consume more organic meat are older than 30 years old. This would mean that the young people would be the group that would eat less meat. The chi-squared test gave the following results:

Table 44. Chi-squared test

X-squared	2.7764
df	2
p-value	0.2495

Again, the test showed that there is independence between the categorical variables "Age" and "organic/regular meat consumption". Thus, there was not enough evidence to reject the null hypothesis and say that there is a significant relationship between them. This means that it is not relevant how old people are to know if they eat or not a certain type of meat[157].

[157] For more detailed information, you can visualize the contingency table as well as the percentages table in Annex 3.

7. DISCUSSIONS

The greenhouse effect as a natural way to heat the planet to allow life to exist is necessary. Without it, life as we know it would not be possible on Earth. The problem is that human activity, through deforestation, burning of fossil fuels, unsustainable transport, excessive waste, the agricultural industry, the soil treatment, the metallurgical, petrochemical, colorant, chlorine industries, the livestock activities, an unsustainable food system, excessive industrialization, among others, directly or indirectly, has raised the GHGs levels so much that the consequences of additional warming and increase of temperature are unpredictable for both the planet and our existence as a species. Thus, the problem is not using the resources that Earth provides us with but exploiting them. We produce more food than we need, we not only use more energy than we need but waste it, we do not use transport responsibly, and we pretend we do not know about it all. Thus, it must be us, not only technicians and scientists but also the general population who take responsibility for it and start making changes to leave a more respectful impact on Earth. Small actions carried out daily create big impacts.

The current models of agriculture and intensive livestock are one of the main causes of climate change and are directly related to the food production industry and the population's eating habits. If we would change towards more responsible and aware food consumption, the production industry would be forced to change too. For this reason, the survey-type research was conducted to analyze the level of awareness of the consumers regarding the current climate situation and its relationship with both regenerative agriculture and their food habits. The idea was to find out if consumers would be willing to change their eating habits for the benefit of the planet or not.

The first remarkable result was that most of the participants considered themselves quite aware of both causes and consequences of climate change. Nevertheless, as a limitation of the study, the answers were self-reported and, of course, were subject to the participant's subjective criteria of what is to have high or low knowledge about something. Most participants stated that the main driver of climate change is GHG emissions, however, less than half of all participants knew that the main reason for these emissions is the agricultural and livestock activities linked, of course, to our food system. Thus, it is evident that there is a lack of knowledge on what really causes climate change nowadays. Before conducting the study, we supposed that young people would be more aware of both causes and consequences of climate change due to their better ability with new technologies and access to online information, but to our surprise, that was not the case as, regardless of the age, most participants seemed to master this subject.

In the same way, most participants stated that they care about their health and nutrition, regardless of how old they are too.

The second important finding was that more than ¾ of the population did not know what regenerative agriculture is. Thus, they also did not know that it is the most viable solution to climate change nowadays[158]. Conversely, most of them said they are highly aware of the solutions to climate change, which does not seem to be accurate. Added to that, people who knew what regenerative agriculture is, had more knowledge of the drivers of climate change than those who did not know it because they were also aware that agricultural activities have an impact on climate and thus, are drivers of climate change. For this, we can conclude that most participants who knew about climate change and its causes, knew about regenerative agriculture as the main solution for it.

The third remarkable result was that, in the same awareness line as above, people who said they know what regenerative agriculture is, hold more responsible habits towards meat consumption. In general, meat consumption is deeply rooted in Spanish culture and more than half of the population still eat meat more than 2-3 times a week. However, another part of the population has indeed started to hold more responsible habits and it is not a coincidence that most of them also know about regenerative agriculture. In fact, all the percentages of the participants who said to know about regenerative agriculture were lower than the ones who did not know about it and only 1/16 said of the first ones said they eat meat every day. We could also find significant differences in the once-a-week meat consumption, in the sense that people who said they know what regenerative agriculture is, responded to eat more meat just once a week than the people who did not, which responded to eat more meat every day. This is another sign that less meat consumption goes by the hand of a higher responsibility towards the climate change situation and the planet in general, also because most of who are aware of regenerative agriculture consume meat in wider time gaps, while those who do not are the ones who eat more meat and more often in time.

When grouping "how often do you eat meat" into 3 groups of "frequently", "rarely" and "never", most of the population, as was expected due to the importance that the meat industry has in Spain, said they eat meat frequently. However, regarding the willingness to reduce, stop or not change the meat consumption eating habits, also most of the participants responded that they would be willing to reduce their meat consumption for the benefit of the planet. Most important is the fact that the majority of the people who stated to eat meat frequently also said they would be willing to reduce their meat consumption, even when being the ones who presented most resistance to change their meat consumption habits. These are good news, considering that a change must happen in that regard. Again, let us remember that these were self-reported answers, so we cannot be sure that they reflect their real will. However, we could not find a significant relationship between the level of awareness of the climate situation and the willingness to change meat

[158] KISS THE GROUND. *Soil Science Resources,* cit.

consumption habits. This shows the fact that the majority of the people did not associate climate change with meat consumption and the meat industry, as it was barely considered as a driver of climate change for most of them, as demonstrated above.

The fourth remarkable result is that, regarding the willingness to change the food habits in general, the young and middle-aged people were more likely to change them compared to the old people, even though most of the people stated that they would change their food habits in benefit of the planet. There were no significant differences found between the young and the middle-aged groups. This information is quite relevant as it shows that the people who will spend more time on Earth are more open to changes, new possibilities, and are willing to adapt to what the situation requires. If the old group were the one keener to change, these changes would not have lasted very long, as they will die sooner. Among "if the quality of the product was better", "if there is a guarantee of eco-sustainable product", "if the price increases", "depending on the rating of other consumers" and "if there is a possibility of an online purchase", the factors that appeared to be the most relevant when it comes to changing the food habits were a better quality of the product and a guarantee that the product is eco-sustainable, which, again, showed that young people may be ready to put the planet's care as a priority and advocate for more environmentally friendly products as well as a better quality for their individual wellness. However, a price increase could hinder it, so it would also be important to tackle this aspect when launching the products.

Let us remark that we have not found any other studies that approach the topic in the same way and so that we could compare it with. Also, this study was aimed to be applicable worldly, but due to the low number of non-Spanish respondents, the results are only significant for Spain.

Finally, we found it surprising that if all participants were so aware of the ongoing climate situation, the percentage of meat consumption was so high and that few knew about regenerative agriculture. Whatever the reason for this lack of information is, it must change now. Climate change is a topic that is always on the table, but it constantly changes. For that, we can never stop updating our knowledge about it and we need to start making small changes that are in our hands and truly commit to it. Mitigating the animal agriculture sector's contributions to climate change needs comprehensive and immediate action by policy makers, producers but also individual consumers. We should try to reduce meat consumption as it would lower down the GHGs emissions on the atmosphere, and it does not imply any risk for our health. Also, the way we grow our food, fibers, and fuels, either puts carbon up into the atmosphere or pulls it down into the ground. The regeneration of soil is the task of our generation and the most viable solution to climate change.

As a suggestion for further research, more specific questions to which participants could only respond yes or no would be better to evaluate their level of awareness equally according to the

own researcher's parameters of it. Then, the researcher could create her or his own scale from 1 to 10, deciding which answers associate with which numbers.

8. CONCLUSIONS

8.1. About climate change, a brief overview.

The greenhouse effect is a natural mechanism through which the Earth's atmosphere warms up. It works naturally and it is necessary for life on Earth to exist because it heats the atmosphere and raises its average temperature.

Global warming is the continuous and gradual increase of the average temperature of the Earth's surface caused by human activities since the early 20th century mainly due to an increase in the GHGs concentration in the atmosphere (increasing the greenhouse effect in turn), responsible for the changes in the global climate patterns[159].

Climate change is a phenomenon caused totally or partially by the increase in the GHGs concentration in the atmosphere, mainly CO_2, directly or indirectly related to human activities such as the use of fossil fuels and deforestation. It is necessary to control the CO_2 emissions that we are throwing into the atmosphere because if this gas continues to increase, we do not know what response the planet's climate system is going to have.

Climate change is nowadays one of the biggest and most threatening concerns of our society. As humans are accountable for it and it affects life throughout the planet, climate change, as well as the other environmental problems that surround it, must be known and understood, not only by technicians and scientists but also by the general population, so we can all make a change towards a more respectful impact on Earth.

8.2. About the drivers of climate change.

Regarding climate change and its drivers, there is no agreement by the scientific community.

The main negative drivers of climate change that emit unbearable quantities of CO_2 into the atmosphere are caused by human activities. Deforestation, burning of fossil fuels, unsustainable transport, excessive waste, the agricultural industry, the soil treatment, the metallurgical, petrochemical, colorant, chlorine industries, the livestock activities, an unsustainable food system, excessive industrialization, among others, are some examples.

[159] GONZÁLEZ, M., JURADO, E., GONZÁLEZ, S., AGUIRRE, Ó., JIMÉNEZ, J., Y NAVAR, J., "Cambio climático mundial: origen y consecuencias", cit., p.378.

Greenhouse gas emissions are the main cause of climate change, not because they exist as they allow life to happen on Earth, but because humans have been increasing its concentration in the atmosphere up to dangerous levels, and the consequences of which are unknown.

The burn of fossil fuels and deforestation are the main anthropic contributions to global warming. Agriculture, and especially livestock, are the main causes of deforestation and the destruction of valuable ecosystems.

Since the Industrial Revolution, fossil energy has been a fundamental driver of technological, social, economic, and development progress and it still plays a dominant role in the current global energy system[160]. Their negative impact is that when burned, they release CO_2. Some of it was stored for millions of years and is now being rapidly returned to the atmosphere, increasing its levels and overheating the planet.

Agriculture is the sector with the most greenhouse emissions worldwide[161]. With the so-called "Green Revolution", industrial agriculture was born. Its aim was the massive increase in food production, moving away from traditional methods. However, this current model of agriculture is one of the main causes of climate change. This type of agriculture uses high degrees of mechanization, high stock densities, large-scale monocrops, high levels of agrochemicals, high-yielding plant and animal varieties, and decreased or absent fallow periods. It also contributes to deforestation, soil degradation, and the destruction of valued ecosystems[162]. This type of agriculture emits three important GHGs, which are carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

The alternative to industrial agricultural production exists. Ecologically based methods consume far less energy and thus release less GHGs than industrial agricultural production. Moreover, agroecological management techniques restore soils and can sequester more GHGs than industrial agriculture.

Considering that most of the agricultural activities are made to provide humans the food that we need to live, changes in the consumption patterns can help to further lower GHGs emissions linked to food.

The system on which livestock is based is one of the main causes of climate change and global warming. In fact, if the European population consumed half the meat they consume, we would be saving planet Earth from between 25% and 40% of the greenhouse emissions. The farm animal

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[160] RITCHIE, H., ROSER, M., *Fossil fuels*, cit.
[161] BERMEJO, I., "Agricultura y cambio climático", cit.
[162] GREENPEACE, *Agricultura industrial*, cit.

sector is the largest anthropogenic user of land[163]. Even though transportation and the burning of fossil fuels have typically been regarded as the main contributors to GHG emissions and climate change, the farm animal production sector is a bigger threat to the environment.

Since the 1940s, the levels of methane emissions from both animals (direct emission) and their manure (indirect emission) have increased due to escalating farm animal populations[164]. Concerning methane, the animal agriculture sector is responsible for 35–40% of annual anthropogenic methane emissions.

Finally, the impact of industrialized farming not just on climate change but on health is major. A growing proportion of the world's population consumes excess protein (especially animal products) and calories, which will lead to human health problems[165]. Mitigating the animal agriculture sector's contributions to climate change needs comprehensive and immediate action by policy makers, producers but also individual consumers. Enhanced regulation is required to hold facilities accountable for their GHG emissions and further investigations need to be done.

8.3. About the consequences of climate change.

If there is no consensus on the causes of climate change, much less there is about the effects it can have on life on the planet.

Changes in the Earth's climate affect most aspects of life in general. Public health, agriculture, water supplies, energy production and use, land use, and development recreation...

The main consequences of climate change are the meltdown of ice and snow, the raise in sea levels, the rise in global temperature, the increase in droughts, the biological consequences that imply the degradation of ecosystems, and the increase in infectious diseases.

8.4. About regenerative agriculture.

Regenerative agriculture is "an approach to farming that uses soil conservation as the entry point to regenerate and contribute to multiple provisioning, regulating and supporting ecosystem services, with the objective that this will enhance not only the environmental (through reversing

[163] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.578.
[164] PAUSTIAN et al., "Agriculture's Role in Greenhouse Gas Mitigation", cit.
[165] KONESWARAN, G., & NIERENBERG, D., "Global Farm Animal Production and Global Warming", cit., p.578.

current global trends of atmospheric accumulation of GHGs) but also the social and economic dimensions of sustainable food production[166]".

Regenerative agriculture can be the first viable solution to climate change through the regeneration of the world's soils, resulting in a rapid stabilization of the Earth's climate, a restoration of lost ecosystems, and a way to create abundant food supplies[167]. This is possible by drawing down atmospheric carbon to all living things, plants and animals.

As paradoxical as it seems, the solution can be found in the same problem, which is not agriculture or farming itself, but how its activities are performed. Thus, regenerative agriculture considers the missing piece: the soil. The soil is the place to store the excess carbon emitted by human activity. Plants, with sunlight and water, perform the photosynthesis, they pull in carbon from the air and turn it into carbohydrates, sugars, which build the biosphere and the soils. Then they pump some of those sugars through the roots down to Earth, to feed microorganisms who use that carbon to build soil. This way, carbon has been already moved from the air to the soil that now stores it.

Every farm is different. Yet, the basic principles that farmers use to build healthy soil are less disturbance, living roots, soil armor, increased biodiversity, animal integration, and planned grazing.

Finally, animals are an essential part of the nutrient cycle, and managing them properly in our agricultural systems is critical for restoring soils and balancing the climate, as they have the potential to reduce GHG emissions and sequester carbon. If we understand how much the massive production of meat detriments the land and the climate, we also understand that this system cannot be held for much longer. Thus, it is important to buy meat from ranchers and farmers who are utilizing regenerative models of meat production, support businesses that are restoring soils and native grasslands, taking good care of their animals, and sequestering carbon through healthy soil practices and holistic management. If oneself aligns with that, naturally the consumption of meat decreases.

8.5. About the study research.

Survey-type research was conducted to analyze the awareness of the consumers regarding the current climate situation and its relationship with both regenerative agriculture and their food habits. Ultimately, the idea was to find out if the current situation envisions a potential change towards better food habits and consequently a preserved environment, or not.

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[166] SCHREEFEL, L. et al., "Regenerative agriculture", cit., p.5.
[167] KISS THE GROUND FILM, cit.

The population analyzed in this statistical study were the consumers around the world in 2021. Nevertheless, we concluded that the results would only apply to Spain due to the small number of participants that were not Spanish. The survey was sent through different social networks (WhatsApp, Instagram…) to people around the world, obtaining a sample of 328 people that completed the whole survey. 113 variables were created for the study and RStudio program was used to do the statistical analysis.

Firstly, the statistical study concluded that there was no relationship between the level of knowledge of the drivers of climate change and age. The main drivers chosen by participants were GHG emissions, human activity, excessive generation of waste, and polluting non-environmentally friendly transport. Nevertheless, the farming and agriculture industries were barely chosen.

Secondly, the awareness of the consequences of climate change was not related to age. The main consequences chosen by participants were the rise in global temperature, the meltdown, the sea levels rise, alterations in rain cycles and more floods, and degradation of ecosystems. The anticipation of spring was chosen by less than half of the participants.

Thirdly, the statistical study concluded that the level of health care that the participants showed was not related to their age.

Fourthly, there were significant differences between the young and the middle-aged group compared to the old people group of age, in which these two ones are more likely to change their food habits than the group of old people. The most influential factors to change the food habits were found to be the better quality of the product and the guarantee of an eco-sustainable product.

Fifthly, a relationship between people who are more aware of the drivers of climate change and their knowledge of regenerative agriculture was found. People who knew what regenerative agriculture is had more knowledge of the drivers of climate change than those who did not know it, as they were also aware that agricultural activities have an impact on climate, and thus chose it as a driver of climate change.

Sixthly, there was a significant statistical relationship between how often people consume meat and the awareness of what regenerative agriculture is. Those who said they know what regenerative agriculture is, hold more responsible habits towards meat consumption. In other words, they eat less meat.

Seventhly, a significant statistical relationship between how often people consume meat and their willingness to change their meat consumption was found. In that sense, most of the people who stated to eat meat frequently also said they would be willing to reduce their meat consumption.

Finally, no strong association was found between eco meat consumption and the level of wealth, neither was found between people's age and the type of meat they consume.

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10. ANNEXES

10.1. Annex 1

Table A1. Socio-Demographic Characteristics of the Study Sample (N=328)

	n	%
Gender	321	100.00%
Male	177	55.14%
Female	139	43.30%
Non-binary	2	0.62%
Others	0	0.00%
Prefer not to say	3	0.93%
Age	325	100%
0 - 30	171	52.62%
31 - 60	98	30.15%
>61	56	17.23%
Continent	327	100.00%
Europe	301	92.05%
Asia	2	0.61%
Africa	20	6.12%
North America	4	1.22%
South America	0	0.00%
Country	324	100.00%
Spain	29	8.95%
Catalonia	229	70.68%
Germany	4	1.23%
Ireland	2	0.62%
England	11	3.40%
Belgium	1	0.31%
Italy	3	0.93%
Taiwan	1	0.31%
South Africa	20	6.17%
Luxemburg	1	0.31%
Rumania	1	0.31%
Netherlands	3	0.93%

Poland	4	1.23%
Austria	8	2.47%
Mexico	1	0.31%
Russia	2	0.62%
Switzerland	1	0.31%
United States	3	0.93%
Location Type	326	100.00%
Rural Village	55	16.87%
City	270	82.82%
Nomad	1	0.31%
Monthly net wage	323	100.00%
0 - 600 euros / 0 - 728 dollars / 0 - 10519 Rands	89	27.55%
601 - 1200 euros / 729 - 1456 dollars / 10520 - 21038 Rands	68	21.05%
1201 - 1800 euros / 1457 dollars - 2184 dollars / 21039 - 31558 Rands	53	16.41%
1801 - 2200 euros / 2185 - 2670 dollars / 31559 - 38571 Rands	54	16.72%
2201 - 3000 euros / 2671 - 3640 dollars / 38572 - 52597 Rands	36	11.15%
3001 - 4000 euros / 3641 - 4854 dollars / 52598 - 70129 Rands	16	4.95%
+ 4000 euros / + 4855 dollars / + 70130 Rands	7	2.17%
Level of education	324	100.00%
Primary/Elementary School	5	1.54%
Secondary School / High School	22	6.79%
Baccalaureate / General Certificate of Education (GCE)	37	11.42%
Vocational Education Training (VET)	15	4.63%
Certificate of Higher Education (HNC)	40	12.35%
University Degree	128	39.51%
Professional/Vocational training	12	3.70%
Master’s Degree (M)	54	16.67%
Doctorate (PhD)	6	1.85%
Private formation	5	1.54%

Table A2. Level of self-care of the interviewed

	n	%
Exercise/Workout	325	100.00%
I do not exercise.	17	5.23%
Few times / seldom	59	18.15%
2 - 3 times a week	35	10.77%
Once a week	39	12.00%
Twice a week	57	17.54%
3 or more times a week	79	24.31%
Every day	39	12.00%
I mind my health[a] (mean, SD)	8.47	1.63
I take care of my nutrition[b] (mean, SD)	7.35	1.83

[a] Item responses were coded 1=not much to 10=a lot.

[b] Item responses were coded 1=not much to 10=a lot.

Table A3. Climate change-related questions

	n	%
Awareness of the climate situation (mean, SD)[a]	6.659443	1.992641
Knowledge of the drivers of climate change (mean, SD)[b]	6.894737	1.916276355
Which of these factors do you think are the drivers of climate change?[c]	328	100
GHG	288	87.80%
Deforestation	262	79.88%
Natural causes	68	20.73%
Human activity	281	85.67%
Burning of fossil fuels	245	74.70%
Agricultural activities	124	37.80%
Farming / livestock activities	175	53.35%
Volcanic activity	53	16.16%
Polluting non-environmental friendly transport	263	80.18%
Excessive generation of waste	276	84.15%
Others	9	2.74%
CO_2 importance as a driver of climate change (mean, SD)[d]	7.558642	1.747076995

What are the drivers of greenhouse gas emissions?[e]	328	100%
Buildings that need energy rehabilitation	92	28.05%
Agricultural activity (new soil treatment, pesticide use, ...)	134	40.85%
Metallurgical, petrochemical, colorant, PVC, chlorine industries ...	238	72.56%
Farming / Livestock activities	154	46.95%
Unsustainable food system (ex: high meat consumption)	182	55.49%
Deforestation	163	49.70%
Energy waste	168	51.22%
Excessive industrialization and consumption	255	77.74%
Others	10	3.05%
Awareness of the consequences of climate change (mean, SD)[f]	6.859375	1.869296445
Do you know what are the consequences of climate change?[g]	328	100.00%
Anticipation of spring	144	43.90%
Rise in global temperature	313	95.43%
Meltdown	283	86.28%
Alterations in rain cycles and more floods	269	82.01%
Sea levels rise	273	83.23%
More episodes of El Niño	120	36.59%
Increase in droughts	246	75.00%
Degradation of ecosystems	267	81.40%
Outbreaks of swine fever	42	12.80%
Increase in infectious diseases	117	35.67%
Others	4	1.22%
Awareness of the solutions of climate change (mean, SD)[h]	4.84845679	2.675834541
Which ones are possible solutions to climate change?[i]	328	100%
Regenerative agriculture	189	57.62%
Planned grazing	138	42.07%
Integration of agriculture and farming	120	36.59%
Sustainable and responsible consumption and production	297	90.55%
Sustainable transports	286	87.20%
Efficient use of natural resources	281	85.67%
Biodiversity conservation	220	67.07%
Waste recycling	288	87.80%
Energy consumption saving	273	83.23%
Buy fair trade products	154	46.95%

Build an urban garden	109	33.23%
Others	10	3.05%
Do you know what regenerative agriculture is?	323	100.00%
Yes	96	29.72%
No	227	70.28%
In which principles is regenerative agriculture based on?[j]	328	100%
Less disturbance	78	23.78%
Living roots	92	28.05%
Soil armor	74	22.56%
Increased biodiversity	98	29.88%
Animal integration	60	18.29%
Integrated approach of each farm	60	18.29%
More disturbance	6	1.83%
Animal removal	9	2.74%
Plant specialization	24	7.32%
Level of responsibility towards climate change and the environment (mean, SD)[k]	6.495384615	2.078136538
Willingness to actively engage in climate change reversion (mean, SD)[l]	7.313291139	2.059422154
Willingness to change my food habits if, if... (mean, SD)[m]		
… the quality of the product was better	7.477987	2.148542101
... the price increases due to a better quality	6.697161	2.120520181
… depending on the rating of other consumers of the product	5.042904	2.609484893
... there was an online purchase option	5.013423	2.912845294
... it was guaranteed that the product is eco-sustainable	7.385350	2.186491063
Meat consumption	327	100%
Once a week	42	12.84%
2 - 3 times a week	179	54.74%
Every day of the week	42	12.84%
2 - 3 times a month	13	3.98%
Rarely	18	5.50%
I don't eat meat	33	10.09%
Mass production of meat is one of the largest contributors to greenhouse gas emissions. Thus, I would be willing to ...	323	100.00%
Reduce my meat consumption	214	66.25%

Stop eating meat	66	20.43%
I would not be willing to change my meat consumption	43	13.31%
Considering that organic/ecological meat, due to differences in its treatment, is healthier than regular/conventional meat, I would be willing to ...	300	100%
Consume organic meat instead of regular meat	272	90.67%
Consume regular meat anyways	28	9.33%

[a] Item responses were coded 1=low awareness to 10=high awareness.
[b] Item responses were coded 1=not much knowledge to 10=a lot of knowledge.
[c]This was a multiple-answer question. Thus, the sum of all percentages is more than 100%.
[d] Item responses were coded 1=low importance to 10=high importance.
[e]This was a multiple-answer question. Thus, the sum of all percentages is more than 100%.
[f] Item responses were coded 1=low awareness to 10=high awareness.
[g] This was a multiple answer question. Thus, the sum of all percentages is more than 100%.
[h] Item responses were coded 1=low awareness to 10=high awareness.
[i] This was a multiple-answer question. Thus, the sum of all percentages is more than 100%.
[j] This was a multiple-answer question. Thus, the sum of all percentages is more than 100%.
[k] Item responses were coded 1=low responsibility to 10=high responsibility.
[l] Item responses were coded 1=low willingness to 10=high willingness.
[m] Item responses were coded 1=low willingness to 10=high willingness.

10.2. Annex 2

Table B1. Contingency table of the variables ñmonthly net wageò and ñorganic/conventional meat consumptionò

Monthly net wage	Organic/conventional meat consumption		
	Organic meat	Conventional meat	Totals
0 - 600 euros / 0 - 728 dollars / 0 - 10519 Rands	75	4	79
601 - 1200 euros / 729 - 1456 dollars / 10520 - 21038 Rands	54	9	63
1201 - 1800 euros / 1457 dollars - 2184 dollars / 21039 - 31558 Rands	44	5	49
1801 - 2200 euros / 2185 - 2670 dollars / 31559 - 38571 Rands	47	4	51
2201 - 3000 euros / 2671 - 3640 dollars / 38572 - 52597 Rands	28	4	32

3001 - 4000 euros / 3641 - 4854 dollars / 52598 - 70129 Rands	14	1	15
+ 4000 euros / + 4855 dollars / + 70130 Rands	6	1	7
Totals	268	28	296

Table B2. Total percentages table of the variables ñmonthly net wageò and ñorganic/conventional meat consumptionò

	Organic/conventional meat consumption		
Monthly net wage	Organic meat	Conventional meat	Totals
0 - 600 euros / 0 - 728 dollars / 0 - 10519 Rands	0.2534 (25.34%)	0.0135 (1.35%)	0.2669 (26.69%)
601 - 1200 euros / 729 - 1456 dollars / 10520 - 21038 Rands	0.1824 (18.24%)	0.0304 (3.04%)	0.2128 (21.28%)
1201 - 1800 euros / 1457 dollars - 2184 dollars / 21039 - 31558 Rands	0.1486 (14.86%)	0.0169 (1.69%)	0.1655 (16.55%)
1801 - 2200 euros / 2185 - 2670 dollars / 31559 - 38571 Rands	0.1588 (15.88%)	0.0135 (1.35%)	0,1723 (17.23%)
2201 - 3000 euros / 2671 - 3640 dollars / 38572 - 52597 Rands	0.0946 (9.46%)	0.0135 (1.35%)	0.1081 (10.81%)
3001 - 4000 euros / 3641 - 4854 dollars / 52598 - 70129 Rands	0.0473 (4.73%)	0.0034 (0.34%)	0.0507 (5.07%)
+ 4000 euros / + 4855 dollars / + 70130 Rands	0.0203 (2.03%)	0.0034 (0.34%)	0.0236 (2.36%)
Totals	0.9054 (90.54%)	0.0946 (9.46%)	1 (100%)

Table B3. Row percentages table of the variables ñmonthly net wageò and ñorganic/conventional meat consumptionò

	Organic/conventional meat consumption		
Monthly net wage	Organic meat	Conventional meat	Totals
0 - 600 euros / 0 - 728 dollars / 0 - 10519 Rands	0.9494 (94.94%)	0.0506 (5.06%)	1 (100%)
601 - 1200 euros / 729 - 1456 dollars / 10520 - 21038 Rands	0.8571 (85.71%)	0.1429 (14.29%)	1 (100%)

1201 - 1800 euros / 1457 dollars - 2184 dollars / 21039 - 31558 Rands	0.8980 (89.80%)	0.1020 (10.20%)	1 (100%)
1801 - 2200 euros / 2185 - 2670 dollars / 31559 - 38571 Rands	0.9216 (92.16%)	0.0784 (7.84%)	1 (100%)
2201 - 3000 euros / 2671 - 3640 dollars / 38572 - 52597 Rands	0.8750 (87.50%)	0.1250 (12.50%)	1 (100%)
3001 - 4000 euros / 3641 - 4854 dollars / 52598 - 70129 Rands	0.9333 (93.33%)	0.0667 (6.67%)	1 (100%)
+ 4000 euros / + 4855 dollars / + 70130 Rands	0.8571 (85.71%)	0.1429 (14.29%)	1 (100%)

Table B4. Column percentages table of the variables ñmonthly net wageò and ñorganic/conventional meat consumptionò

	Organic/conventional meat consumption	
Monthly net wage	Organic meat	Conventional meat
0 - 600 euros / 0 - 728 dollars / 0 - 10519 Rands	0.2799 (27.99%)	0.1429 (14.29%)
601 - 1200 euros / 729 - 1456 dollars / 10520 - 21038 Rands	0.2015 (20.15%)	0.3214 (32.14%)
1201 - 1800 euros / 1457 dollars - 2184 dollars / 21039 - 31558 Rands	0.1642 (16.42%)	0.1786 (17.86%)
1801 - 2200 euros / 2185 - 2670 dollars / 31559 - 38571 Rands	0.1754 (17.54%)	0.1429 (14.29%)
2201 - 3000 euros / 2671 - 3640 dollars / 38572 - 52597 Rands	0.1045 (10.45%)	0.1429 (14.29%)
3001 - 4000 euros / 3641 - 4854 dollars / 52598 - 70129 Rands	0.0522 (5.22%)	0.0357 (3.57%)
+ 4000 euros / + 4855 dollars / + 70130 Rands	0.0224 (2.24%)	0.0357 (3.57%)
Totals	1	1

10.3. Annex 3

Table C1. Contingency table of the variables ñorganic/conventional meat consumptionò and ñageò

Organic/conventional meat consumption	Age			
	0-30 years old	31-60 years old	<61 years old	Totals
Organic meat	135	88	47	270
Conventional meat	18	5	5	28
Totals	153	93	52	298

Table C2. Total percentages table of the variables ñorganic/conventional meat consumptionò and ñageò

Organic/conventional meat consumption	Age			
	0-30 years old	31-60 years old	<61 years old	Totals
Organic meat	0.4530 (45.30%)	0.2953 (29.53%)	0.1577 (15.77%)	0.9060 (90.60%)
Conventional meat	0.0604 (6.04%)	0.0168 (1.68%)	0.0168 (1.68%)	0.0940
Totals	0.5134 (51.34%)	0.3121 (31.21%)	0.1745 (17.45%)	1 (100%)

Table C3. Row percentages table of the variables ñorganic/conventional meat consumptionò and ñageò

Organic/conventional meat consumption	Age			
	0-30 years old	31-60 years old	<61 years old	Totals
Organic meat	0.5 (50%)	0.3259 (32.59%)	0.1741 (17.41%)	1 (100%)
Conventional meat	0.6429 (64.29%)	0.1786 (17.86%)	0.1786 (17.86%)	1 (100%)

Table C4. Column percentages table of the variables ñorganic/conventional meat consumptionò and ñageò

	Age		
Organic/conventional meat consumption	0-30 years old	31-60 years old	<61 years old
Organic meat	0.8824 (88.24%)	0.9462 (94.62%)	0.9038 (90.38%)
Conventional meat	0.1176 (11.76%)	0.0538 (5.38%)	0.0962 (9.62%)
Totals	1 (100%)	1 (100%)	1 (100%)